POPULATION STRUCTURE OF INDIAN CITIES :
A Case study of the Cities of Bihar

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RAM DAYAL SINGH

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Dedicated
To
My Parents and Teachers

"Intra-urban spatial structure is concerned with the disposition of human socio-economic activities in urban areas, and its goals are to discover, explain and ultimately predict the regularities that exist in man's adaptation to city space."

—L.S. Bourne

"A city is a vast collection of memories and expressions of emotion, with its greatest concentration of human meanings at its centre, and a gradual thinning out of emotional value until one reaches the drabness of the fringes."

—M.W. Gross

". . . there is much to love and to admire in the great city. It is the home of the highest achievements of man in art, literature and science: the source from which the forces of freedom and emancipation have sprung."

—W.A. Robson

"Civilization begins in the peasant's hut, but it comes to flower only in the city. For, in the city are gathered, rightly or wrongly, the wealth and brains produced in the countryside. . .".

—W. Durant

PREFACE

THE importance of the study of towns in their various facets and dimensions has been abundantly recognised during recent years in both developed and developing countries. These urban communities are centres of diverse functions and large-scale employment, especially in secondary and tertiary activities. In India, however, despite the increasing number of social scientists interested in urban problems, scientific study of the problems of cities and urbanisation have been rather haphazard. In newly industrialising countries, the unprecedented rate of population growth, the fantastic rural overcrowding, the drastic steps to bring about economic development—all have caused huge waves of rural-urban migration. The result is that not only population densities are greater in the individual metropolises but large-scale differential densities occur within it because of sectoral clustering of centres. This must inevitably affect the size of civic amenities and the provision of other services. These phenomena have created a series of problems in urban areas such as acute scarcity of residential housing, congestion in the downtown district, creation of slums and blighted areas, unhygienic buildings, etc. The projected population growth particularly in the working age-group may create social problems like unemployment, beggary and crime, etc.

In view of the above, I have undertaken the present study with the primary objective of examining critically the intra-urban variations of population in the cities of Bihar. Barring a few works on the urban geography of individual cities, study of areal differentiations of demographic attributes in urban areas in India has not been carried out previously. Hence, I am extremely thankful to my supervisor, Dr. P. Dayal, Ph. D. (London), University Professor and Head of the Department of Geography, Patna University, Patna, who inspired me to undertake the research project for doctoral thesis on the vital problem of population—space relationship in the cities of Bihar. I express my special gratitude to him for his constant and unfailing guidance and advice at every stage of the prepartion of this thesis in a period of five years.

I will ever remain indebted to Dr. L.N. Ram, Ph.D. (Pat.), Professor in the Department of Geography, Patna University, who despite being hard

pressed for time, helped me and gave his valuable suggestions whenever I met him.

To Dr. A.K. Dutt, Ph.D. (Pat.), Professor of Geography, Akron University (U.S.A.), Dr. R.L. Singh, retired University Professor of Geography (B.H.U.), and Dr. A.B. Mukherjee, Professor and Head of the Department of Geography, Chandigarh University, who had been at Bhagalpur University as Visiting Professors, I express my sincere gratitude for enabling me to discuss the problems and for their valuable suggestions.

I am also indebted to Dr. S.M. Karimi, Professor and Head of the Department of Geography, Patna College, Patna, for his advice and discussion. I am thankful to Dr. B. Thakur, Reader in Geography, Delhi University whose co-operation and inspiration and valuable guidance have been of immense help to me.

I am specially indebted to Sri R.D. Mishra, Reader and Head of the Department of Statistics, Bhagalpur University who provided necessary facilities and kindly allowed me to work in the department for computation of data and to Sri Damodar Tiwari, U.G.C. Fellow, Department of Statistics, Bhagalpur University, who was kind enough to help me in solving statistical problems. I am equally thankful to Sri R.B. Ram, Research Officer, Demographic Research Centre, Patna University, who has given me considerable assistance in the statistical analysis.

My thanks also go to my other senior teachers and colleagues in the Geography Departments of Patna and Bhagalpur Universities for their ready help and co-operation in the course of my research. A work of this magnitude could not have been completed without the help of a large number of persons including officers and assistants of different Government and non-Government Offices whom I had to contact during my field survey. I, therefore, express my sincere gratitude to them for their kindness and courtesy and the assistance which they provided most cheerfully.

I am deeply indebted to the Department of Town and Country Planning Organisation, Government of Bihar, various Municipal and other local bodies for the supply of required maps and data. Finally, I would like to express my thanks to Shri B.P. Mandal, for having painstakingly typed the thesis.

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INTRODUCTION

Importance of Urban Population Study

STUDIES with regard to different aspects of population have attracted the attention of many social scientists but it is only recently that attempts are being made to investigate systematically the causes of concentration of population in urban areas. The rapid population increase, specially in large urban centres poses a serious challenge to the development efforts of the less developed countries like India. The task of providing food, educational facilities, employment, health facilities and housing, etc., for the increasing numbers has become staggering. In modern times, cities, towns and other service centres are rapidly expanding in size and importance throughout the developed and developing world. The introduction of modern means of communication and automobile transportation has not only facilitated their growth but has brought with it a number of new and extremely complex problems for society, in addition to the traditional ones which in the process too have become worse and more complicated. An increasing awareness of the problems created by rapid and unplanned urban growth and the deterioration of urban environment has accelerated interest in understanding the complex process and problems of metropolitan growth. Thus, the study of cities with respect to their various components of population attains paramount importance specially at the stage of increasing pace of over population, congestion and unhealthy living.

Until recently, much of the population growth and migration to cities has been accommodated by crowding more and more people into existing urban areas rather than by expansion of cities into suburbs and fringe areas. In contrast to western countries, urban sprawl is not yet an important feature in India. This is reflected from the fact that there is an extraordinary centralisation of population around the principal commercial areas of the cities. The central parts of most Indian cities certainly retain a locational advantage and some traditional prestige as a

place of residence for people of high social status with above average literacy level and income.[1] The sparsely populated fringe areas, on the other hand, are commonly occupied by a mixed low and middle income group people, though there are examples of peripheral sectors with new residential colonies of high status population.

Such studies are important not only from the academic point of view but even more so as providing scientific basis for practical decision making in governmental business and social affairs. Concurrent with this rapid growth in urban population and its complex spatial ramifications, it is natural that geographers should become more involved in urban studies. It is not surprising, therefore, that urban geography has emerged in the recent past as a particularly important area of inquiry and there can be little doubt concerning its continued growth and importance.

The present work attempts to study the cities in the State of Bihar with respect to their vital demographic components. These cities, numbering nine, have been subjected to an analysis of their demographic characteristics in terms of the population size, historical and current growth, inter-city and intra-city demographic changes, rank size and population growth and population density patterns in the light of the existing concepts and generalisations.

The study of the urban geography may be conventionally divided into two sections, viz., firstly, the study of size, number, growth and spatial distribution of inhabitants in the cities; and secondly, the study of the patterns, internal and external shape of the city. The former can be broadly kept under demographic study while the latter constitutes the morphological study of cities. Both the branches have quite distinct status, importance and scope. The present appraisal, however, relates to the first aspect of the study. Hauser and Duncan[2] define demography as the study of the size, territorial distribution and composition of population changes therein and the components of such changes which may be identified as natality, mortality, territorial movement and social mobility. In population geography, we study demography in terms of areal differentiation of population and other population attributes in their distributional aspects and also the dwelling patterns and their interrelationships.[3] Clarke,[4] a British population geographer distinguished population geography from demography by emphasing the former's concern with understanding spatial variation of demographic variables by seeking measures of areal coincidence with other related variables. He states that "while the demographer is devoted to numbers and depends heavily upon statistical methods, the population geographer relates numbers to area and relies upon maps".

Some Basic Definition of City

Before attempting to analyse the fundamental elements of the present study, it seems pertinent to give some basic definitions of the city and town. Definition of the term 'city' or 'town' is rather confusing since there is no clearcut or sharp boundary to demarcate the rural from the urban areas. Many attempts have been made to define towns or urban centres, and they are based mostly on demographic features such as strength of population, density of population, human occupance and social and cultural behaviour of man, etc. Most countries establish urban areas on the basis of population, some distinguish between urban and rural community on the basis of local government, administrative decisions or the major occupations of inhabitants.

In the United States, for example, urban areas must incorporate at least 2500 inhabitants and certain unincorporated but thickly settled areas.[5]

Smailes pointed out, "A town may be regarded as first and the foremost of community of people pursuing a distinctive way of life as compared with the rural pupulation of the country-side or it may be considered as a part of the earth's surface, differentiated from rural surroundings by a particular type of human transportation with buildings and other distinctive structures".[6]

Dickinson describes some measures of community service and organisation what is sometimes called community balance. Thus, he contradicts the statement of geographers who believe in municipality of occupation as the city's distinctive feature.[7]

"The city is, in fact, the physical forms of the highest and most complex types of associative life. It exemplifies to a greater extent than a town the dominant elements of the cultural realm in which it lies and usually displays the most monumental architectural forms".[8]

According to Hudson, "A city may be regarded purely as a leading town, i.e., one which has outstripped its local or regional rivals".[9]

One of the most explicit is Louis Wirth's famous definition of a city as "A relatively large, dense and permanent settlement of socially heterogeneous individuals".[10]

From the above definitions it is apparent that population and their attributes are the main basis for defining the rural-urban centres while the city may be regarded as a relatively large size urban community with complex socio-economic and cultural diversities.

Definition Employed in India

The Census authorities of India define cities and towns in respect of population structure and economic activities.[11] The following are the criteria for the recognition of urban centres.

1. The places should have a population of not less than 5000.

2. These must be governed by Municipality or Notified Area Committees or Military Cantonments.
3. These should have a density of not less than 1000 persons/sq. mile.
4. Three-fourths of the working force should be engaged in non-agricultural activities.

On the basis of the above definition, the Census of India, 1971 declared 203 places as urban centres in Bihar, which were further classified into six categories based mainly on the size of population. The urban centres having inhabitants—

1.	100,000 or more	Cities or Class I Towns
2.	50,000—99,999	Medium Size Towns
3.	20,000 - 49,999	
4.	10,000—19,999	Small Size Towns
5.	5,000 –9,999	
6.	Below 5,000	Townships

Cities and towns are, thus, best determined in terms of the size of inhabitants and structure of their population. An urban place is distinguished from a rural agglomeration by having a larger population and a considerable degree of division of labour both in industrial production and in many other services. Density of population is another distinguishing factor from rural-urban agglomeration. In addition to this, occupational structure of the working force is also one of the most important classifying attributes in urban areas.

Survey of Previous Literature

Considering some of the important related previous urban studies, it will be noted that researches so far made in India generally deal with location, evolution, growth, functions and spatial arrangement among various towns, while studies on intra-urban variations are scarcely seen. Geographers have paid less attention to study the distributional aspects of demographic attributes within cities.[12]

In Europe, most of the urban studies are related to the morphological features. Special mention may be made of the work of Dickinson.[13] There are other important works by Smailes,[14] Sjoberg,[15] Everson,[16] etc., on morphological aspects of urban geography of cities or regions. In addition, there are some works on ecological organisation of European cities specially with regard to the functional analysis and land use patterns. Demographic aspects of the cities in detail have generally been neglected by European geographers. In the past few decades, Colin Clark, a British economist investigated the fundamental Negative Exponential Law[17] of decline of population density from the city centre. Clark in support of his argument collected several evidences from different parts of the world.

He also found that the distribution of people between high and low density residences is influenced by their incomes, present and expected work places, their comparative taste for open spaces or for city amenities, etc. Clark's great contribution formed the basis of later researches but it was not sufficient for universal application. Later, Soviet geographers made quite successful attempts in the study of urban population density with reference to different parameters. In particular, Gurevich,[18] while interpreting the patterns of population density in a Soviet city, indicated the need for models both for urban planning and for development of theories in geography. Decey[19] also suggested a model for areal distribution of population in a city in the context of several population centres. Papageorgiou[20] suggested an alternative approach to the hierarchy of centres which differ in density patterns of population depending upon their sizes. Haynes and Rube[21] adopted an approach based on lines of equal population density about a single centred city. They explicitly modelled angular or directional variation in urban density and created a fivefold typology for single centred cities.

The extraordinary contribution of Clark with regard to spatial variation of urban phenomena could receive global support and a sound theoretical foundation was established by later researches of American geographers where contribution in this field has been relatively large. In Chicago, the classic centre of urban research, geographers and other social scientists have been specialising in this field since long. The names of Berry, Simmon, Tennant, Newling, Sharratt, etc., may specially be mentioned as they expressed their divergent opinions in connection with spatial distribution of demographic attributes within urban areas. Their ideas were primarily based on Clark's findings (Negative Exponential Decline of Density), but they subsequently modified to make it more appropriate and universal in application. Berry and his associates,[22] after their worldwide investigation of some 100 cities, found the law to be most satisfactory explanation of Clark's original model though it needs certain modifications with the changing time and space. In addition to their own observations, they also examined the works of many other social scientists like Muth, Stewart, Weiss, Alonso, etc., and found the rule to hold a good fit.

In order to give a sound theoretical rationale, Berry and his colleagues[23] also devised at least 10 more equations for different sets of cities. For instance, the equation (8) illustrates that as the population of a city increases the density gradient diminishes or that smaller cities are more compact than larger ones by virtue of their steep density gradient. They further observed that the density gradient patterns change with the change in city size and present sharp contrasting models for western and non-western countries. As western cities grow through time, they experience a steady decrease in density gradients and, therefore, in

the degree of compactness whereas central densities first increase and later decrease. To the contrary, in non-western cities the central densities increased steadily but urbanised areas relatively expanded little and hence the density gradient remained constant.

Recently, Brush[24] examined the spatial distribution of population in Indian cities and found that the overall patterns are more or less the same as observed by Clark and Berry, *et al.* Moreover, Indian cities because of complex internal structure show some definite departures from the above models. The most common pattern is found in cities which are characterized by single predominant population centre, situated in or adjacent to the indigenous *bazar*. Within one mile and a half or so from the centre, the density gradient slopes sharply downwards to the periphery. The second important pattern exists in the British built port cities where the CBD is mainly occupied by offices, banks, hotels, commercial activities, etc., and therefore, the density gradient is relatively low. The most distinct pattern has been observed in those cities which are characterized by two separate nodes of population concentration, one around the traditional *bazar* and the other around the British developed centre which is usually a little distance away from the old city area. Finally, the modern planned cities are also reported to have some different density gradient simply because of low population density in general.

In Asian countries, research in this field has not been given due attention, though a few works of considerable value have appeared in India, China and Japan. In India, quite a good number of studies on urban problems, mainly with the components of population, have sprung up during the last three decades following the pioneer work of Singh.[25] Nevertheless, the contribution of Indian geographers in this field remains very small. It is true that a large number of papers on population relating to distribution, density and growth have appeared in Indian journals, but there has been a conspicuous lack of geographical studies on spatial aspects of urban phenomena.

As early as 1941, Kurian[26] described the distribution of population in Madras city. The demographic structure of Allahabad was analysed by Singh[27] and later by Dwivedi.[28] Siddique[29] studied the population characteristics of Moradabad city, Chatterjee[30] of Howrah and Singh[31] of Lucknow. Thereafter, a number of Indian scholars wrote doctoral dissertations on the geography of individual cities and towns. In most of these studies, there is lack of emphasis upon intra-urban variation of population characteristics. Ahmad,[32] in his study of Indian cities has attempted to trace out their salient demographic and morphological features. Lal[33] paid attention to the impact of immigration on urban growth by undertaking a special investigation of eight cities. Dutt[34] examined the patterns of growth of urban population in India. He also paid special attention to

the intra-urban growth and variation of population in which he supported Brush's derivations of density gradients patterns in Indian cities.

Apart from these, there are numerous works on cities related to land use patterns, growth trends and functional classification, etc. But studies on spatial variations of demographic attributes are rare. This branch of urban geography has been virtually neglected in India both by geographers and other social scientists; though it must be admitted that there are references to population characteristics of the cities in Bihar in the works of Dutt,[35] Singh,[36] Sharma,[37] Ahmad[38] and Ram.[39]

As the field of urban geography even crosses the boundaries of many other social disciplines, the scholars of other social sciences are also equally concerned with the interplay of forces of demographic variables. They have contributed a lot of materials on urban problems especially with regard to the components of population and socio-economic attributes of Indian cities. Davis,[40] in his study of the major trends of urbanisation in India and Pakistan discussed the density variations in some large selected cities. Because cities vary widely in the amount of vacant land included in their boundaries, their densities cannot be compared. More recently, traditionalist and revisionist groups of human ecologists have contributed papers dealing mainly with variation of population densities and population growth in the cities of U.S.A. The traditionalist, Hawley[41] is of view that the city structure is largely a result of fierce economic competition for location near the CBD which is attractive to all types of activities because of its accessibility to jobs, transportation point and market. This would result in general population concentration around the CBD which decreases with the increase of distance from the city centre outward. He later stated that further increase in population eventually leads to declination of the central city by peripheral expansion. The revisionist[42] view, on the other hand, is based on modern transportation technology. The rapid change in the system of transport has not only influenced the movement of business, industry and other services but also resulted in large suburban sprawl of the city. Both the views are really complementary to each other and there is no basic difference in their approach. Guest[43] also stated that until the introduction of modern transport system, the traditionalist concept was of considerable inportance but the recent city sprawl is largely influenced by improved means of communication facilities which is the revisionist opinion.

Among Indian social scientists, Bose[44] in a sample survey study (covered in the Census publication) attempted to trace out the socio-economic features of Indian cities. He felt that the mushroom growth of cities as revealed in the 1951 Census resulted in surmounting pressure of people on the limited urban space available due to incessant rural-urban migration. Zachariah and Mitra[45] paid special attention to the growth

of cities on account of rural-urban migration. Desai[46] also delineated in his study of the basic demographic characteristics of size, growth and distribution of population in Indian cities. Chandrashekhar[47] studied the population growth and its distribution in Madras city.

Statement of the Problem

From the aforesaid analysis it is apparent that studies on the cities of Bihar, specially on intra-urban scale, are practically non-existent. Within limited areas of urban space, the magnitude of pressure of population has risen to such an extent that a number of problems like shortage of housing, unhygienic buildings, traffic congestions, unemployment, beggary, crime, etc., have become acute and are likely to become still more acute with further increase in population. In these circumstances, there is a growing need for detailed comparative study of intra-urban variation of population in the cities of Bihar in relation to their current and potential resources.

The principal objective of the present research is to investigate and analyse: how are the city dwellers spatially distributed over the limited urban space? Is there any empirical regularity at least in broad perspective to be reckoned? Are the existing population density patterns tend to follow conformance with those observed by western geographers? What are the causes of varying population density patterns? As all the distributional aspects of the number of people are nearly inseparable from the concept of population density, the study has largely been devoted to make an intensive analysis of the patterns of population distribution. Furthermore, people in urban areas are not evenly distributed, instead, they tend to follow some definite empirical regularity. The aim of the present study is, therefore, to examine critically the current population density patterns in relation to theoretical concepts developed by geographers and other social scientists. Besides, the author has also endeavoured to analyse the growth of population in terms of inter-city and intra-city population changes and their impact on population density patterns. Consequently, our account must include an assessment of the general factors affecting the density pattern. As population density pattern is largely the result of interaction of complex physical, socio-economic and cultural factors, some of the important indicators have been selected for statistical enquiry of the problem.

The present work is restricted to the Class I towns as defined by the Indian Census, or those having a population of 100,000 or more. Their number is 9 in the State comprising about 35 per cent of the total urban population. As compared with smaller towns larger cities exert a more far-reaching influence on the economic development of the region. The study of urban centres of this size is, therefore, of special importance for

formulation of policy and strategy for regional development by the Government.

Method of Study

For the greater part of the study, a systematic approach has been applied and a balanced geographical account of spatial distribution of population in the cities of Bihar based on available statistics has been attempted. The works so far carried out have been primarily descriptive and non-statistical. In the present work, processing and quantification of data in varying degrees have been accomplished in order to arrive at a more scientific and reliable conclusions.

Correlation techniques are among the most widely used methods of numerical analysis in geography. In the present work, these have been used to describe the areal association and to infer causal relationships. Correlation methods are also popularly used to test hypotheses concerning cause and effect. Thus, linear regression and product moment correlations co-efficient methods have largely been taken into account especially in the State of data being confirmed on interval scale. It has also been noticed that the data were derived from normal population and the association was linear. The method has been, thus, helpful in delineating the causal association between population density and selected variables like commercial area, accessibility, urban function, proportion of scheduled castes and scheduled tribes, and literacy while multiple correlation technique has been selected for weighing their joint impact on the patterns of population in the cities of Bihar.

In the circumstances when the data of geographical occurrences are available on ordinal scale, Spearman's rank correlations method, as most frequently used, has been adopted for measuring the degree of association between a set of ranked attributes. The method has been applied to examine the trends of population growth in the cities of Bihar in respect of their population sizes. As the spatial distribution of city dwellers is influenced by a large number of social factors, application of social theory over the cities of Bihar has also been examined.

Sources of Data and its Reliability

In geographical studies it is quite possible that necessary data will be collected from more than one source. The basic data for study have been made available from various documentary (published and unpublished) sources. Most of the published statistics have been collected from decadal Census publications in which detailed informations with regard to spatial aspects of population characteristics are available. Thus, the census data have largely been helpful in Chapter 3, in delineating population growth,

inter-city and intra-city population changes and their impact on population density patterns in the cities of Bihar.

While much of the data were available in printed form, an even greater amount was collected in unpublished forms from various sources including the government departments and in the course of field work. Some of the unofficial statistics gathered from field surveys may be regarded as primary data. Their main importance as with some of the official statistics lies in the fact that this information was used to substantiate conclusions, based on other information. Data of land given to commercial uses was computed for every city with the help of the existing land use map and field surveys in order to show the areal distribution and their association with population variations within cities. Similarly, statistics of density of roads for each city were calculated to examine its impact on residential segregation.

A major difficulty faced in the present study was the limited time and man-power available for collecting relevant data. The author's major task was, therefore, to compile systematic spatial data based on raw data before any analysis could be taken up. Such data show not only connections between places of occurrence but also rank the quality of these connections and scale of their intensity. To establish relationship among various spatial units bearing diverse characteristics is the primary aim of geographers. The collection of appropriate and quantified data, thus, become vital for presentation of scientific analysis.

Maps and Diagrams

Maps and diagrams have always occupied a place of central importance in the visual presentation of geographical data. The following maps have been used as base maps and have been procured from different sources. The outline maps bearing detail characteristics of statistical units (census wards) have been made available from Improvement Trust, Municipal Offices and Notified Area Committees. The maps of some of the adjoining townships of Jamshedpur and Patna forming parts of agglomerations are not available as there does not exist any municipal body. Therefore, their boundaries have been adjusted with the maps available in the District Census Handbooks, in consultation with the Development Authority.

The Department of Town and Country Planning Organisation, Government of Bihar has rendered considerable assistance in providing extensive existing land use maps of the cities in Bihar. These maps have formed the basis of estimating the spatial variations of economic activities and spread of human occupance units in the changing time and space.

As regards the technique of mapping and construction of diagrams, general principles have been followed. Choropleths, isopleths, scatter diagrams, proportionate circles and line graphs based on logarithms and

semi-logarithmic scales have largely been used in the completion of the work. Several maps have also been drawn to illustrate the results of various statistical techniques applied to analyse and interpret the available data.

Field Survey

In any geographical study of a region, it becomes essential to make direct field survey of the area. In order to study the cities, especially on intra-urban scale, field investigation is the most essential requirement as the researcher has to establish the ecological foundation of various urban phenomena. In completion of the present work, therefore, several visits were paid to all the cities under study. Field observation was initially conducted to collect relevant data and municipal ward maps as also to make acquaintance of the existing civil wards and the city limits.

Investigation of the cities was specially required in the principal commercial areas because it was the place from where systematic zoning of the cities at equi-distance was possible and on that basis, the final data could be organised for spatial variations. Although the work is largely based on the census tables, field survey was made to ascertain the reliability of data in some specific localities. With the help of existing land use maps, a comprehensive and detailed survey was conducted in order to allocate the commercial areas and transport networks within the cities so as to make correspondence with population distribution. The last step was to trace out some unique features of the urban areas by means of photographs.

The Structural Organisation of the Study

The ordering of chapters represents a flow chart of ideas which they contain in detail. Each and every chapter is inter-related and develops a theme which leads directly to the materials in all subsequent sections. The introductory chapter attempts to conceptualise the topic such as the importance of urban population study, definitions of towns and cities, survey of the previous literature, statement of the problem and methodology adopted in the present analysis.

In Chapter 2, the study is largely devoted to the description of the general geographical features of the study area. An attempt has been made to give in brief the physical and economic characteristics of the State of Bihar and their impact on the growth and evolution of cities and towns. In this context, theoretical views regarding location have also been taken into account. In the third chapter, general population growth in the cities of Bihar has broadly been discussed in the light of following sub-headings—changes in population of the cities during inter-censal decades, inter and intra-city growth patterns, rank size and growth of cities, movements of ranks through census decades and future estimate of the cities population.

Chapter 4 examines the intra-urban spatial variation of population in

the cities of Bihar in the light of existing negative exponential explanation long established by Bleicher and Clark. The study also overviews, in brief, the works of renowned scholars who laid a sound theoretical foundation based on a large number of evidences from all over the world in support of the concept.

Chapter 5 discusses the factors influencing the density patterns in urban areas in general. Broadly speaking, historical, geographical, socio-economic and cultural factors have been responsible for wide variation in the distribution of population in cities. As such, the population density patterns in urban areas diminish with the increase in distance, many other demographic attributes like literacy, working force and sex ratio, etc., also sharply decline as distance increases from the city centre. Likewise, the intensity of land use, urban function and accessibility patterns are radically reduced at the fringe of urban areas. These attributes directly influence the concentration of city dwellers at the centre and subsequently the density gradients.

The epilogue gives the summary and conclusion drawn from the above study. The widespread interest in urban population research is warranted, since a large proportion of the State's urban population resides in cities and which have considerable impact on regional economic development. The impetus of urban population study is, therefore, increasing as a consequent upon the rapid growth of cities due to rural urban migration. The conclusion arrived at clearly shows the spatial distribution of city dwellers and the factors responsible for the emerging pattern.

REFERENCES

1. Brush, J.E., 'Growth and Spatial Structure of Indian Cities', in Indian Urbanisation and Planning (Eds. Noble, A.G. and Dutt, A.K.), Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977, p. 65.
2. Hauser, M.P. and Duncan, O.D. (Ed.), The Study of Population; An Inventory and Appraisal, Asia Publishing House, Bombay, 1959, p. 2.
3. Ackerman, A.E., Geography and Demography, in The Study of Population; An Inventory and Appraisal (Ed. Hauser, M.P. and Duncan, O.D.), Asia Publishing House, Bombay, 1959, p. 718.
4. Clarke, J.I., Population Geography, Pergamon Press, London, 1965, p. 2.
5. Theodore, Shabad, The Population of China's Cities, Geographical Review, Vol. 50, January 1959, p. 441.
6. Smailes, A.E., Geography of Towns, Hutchinson, London, 1953, p. 32.
7. Dickinson, R.E., City Region and Regionalism, Routledge, London, 1947, p. 20.
8. Mumford Lewis, The Culture of Cities, Secker and Warburg, London, 1938, p. 5.
9. Hudson, F.S., A Geography of Settlements, Macdonald and Evans Ltd., London, 1970, p. 9.
10. Wirth, L , 'Urbanisms as a Way of Life', American Journal of Sociology, Vol. 44, 1938, p. 5.

11. Census of India, Bihar, Vol. IV A, Part-II, 1961, p. 10.
12. Ackerman, A.E., Geography and Demography in 'Readings in Population Geography', (Ed. G.J. Demko *et al.*), McGraw Hill, New York, 1970, p. 33.
13. Dickinson, R.E., The West European City, Routledge, London, 1951.
14. Smailes, A., The Urban Mesh of England and Wales; Transactions of the Institute of the British Geographers, No. II, 1946, pp. 87-101.
15. Sjoberg, G., The Pre-Industrial City, Free Press, Glenco, 1960.
16. Everson, J.A. and Fitzgerald, B.P., Inside the City, Longman, London, 1972.
17. Clark, Colin, Population Growth and Land Use, McMillan, London, 1967, pp. 340-41.
18. Gurevich, B.L., The Density of Population of a City and the Density of Probability of a random magnitude, Soviet Geography, Review and Translation, Vol. 8, 1967, pp. 722-30.
19. Dacey, M.F., A Model for the Areal Distribution of Population in a city with multiple population centres, Tijdschrift Voor Economische in Sociale Geografie, Vol. 59, 1968, pp. 232-36.
20. Papageorgion, G.J., A Generalisation of the Population Density Gradient Concept, Geographical Analysis, Vol. 3, 1971, pp. 121-27.
21. Haynes, E., Kingsley and Rube, I. Milton, Directional Bias in Urban Population Density, Annals of the Association of American Geographers, Vol. 63, 1973, pp. 40-41.
22. Berry, Brian J.L., *et al.*, Urban Population Densities: Structure And Change; The Gographical Review, Vol. 53, 1963, pp. 389-405.
23. Berry, *op. cit.*, p. 392.
24. Brush J.E., Spatial Pattern of Population in Indian Cities; The Geographical Review, Vol. 58, 1968, p. 362.
25. Singh, R.L., Banaras : A Study in Urban Geography, Nand Kishore and Bros., Varanasi, 1955.
26. Kurian, G., Distribution of Population in the City of Madras; Indian Geog. Journal, 1941, Vol. 16.
27. Singh, U., Demographic Structure of Allahabad, Nat. Geog. Jour. of India, Vol. IV, 1958.
28. Dwivedi, R.L., Origin and Growth of Allahabad, Indian Geog. Jour., Vol. 38, 1963.
29. Siddique. M.A., Composition of Population of Moradabad City, Geographer, Vol. 10, 1958.
30. Chatterjee, A.B., Demographic Features of Howrah City, Geographical Review of India, Vol. 20, 1958.
31. Singh, S.P., Demographic Features of Lucknow, Nat. Geog. Jour. of India, Vol. 15, 1959.
32. Ahmad, S.K., Indian Cities : Characteristics and Correlates, Chicago Univ. Press, Chicago, 1965.
33. Lal, Amrit, Patterns of Immigration in Indian Cities, Geographical Review of India, Vol. 23, 1961.
34. Dutt. A.K. (Ed.), India : Resources, Potentialities and Planning; Kendalt-Hunt Publishing Co., Iowa, 1973.
35. Dutt, A.K., Jamshedpur and Its Umland : A Study in Urban Geography, Ph.D. thesis (unpublished),Patna University, Patna, 1959.
36. Singh, S.P., Bhagalpur : A Study in Urban Geography, Ph.D. thesis, (unpublished), B.H.U., Varanasi, 1963.

37. Sharma, N.P., Ranchi, A Study in Urban Geography, Ph.D. thesis, (unpublished) Magadh Univ., Bodh Gaya, 1977.
38. Ahmad, E. and Srivastava, B., Growth, Morphology and Ethnic Character of Ranchi-Dhurwa Urban Complex in Osmania Univ., 1976, pp. 513-42.
(ed. Alam, M. & Pokshishevsky, V.V.), 'Urbanisation in Developing Countries',
39. Ram, L.N. and Thakur, B., Ecological Study of Gaya, Geographical Outlook, Ranchi Univ., Ranchi, 1973.
40. Davis, K., The Population of India and Pakistan, Princeton Univ. Press, New York, 1951, p. 144.
41. Hawley, A.H., Population Density and the City, Demography, Vol 9, 1972.
42. (*a*) Winsborough, H.H., City Growth, and City Structure, Jr. of Regional Science, Vol. 4, pp. 35-39.
(*b*) Schnore, Leo, Metropolitan Growth and Decentralisation in The Sub-Urban Community. (Ed. William, M.D.), Putnaw, New York, 1958, pp. 3-20.
43. Guest, M.A., Urban Growth and Population Densities, Demography, Vol. 10, 1973, pp. 53-68.
44. Bose, A., Urbanisation in India, Academic Book Ltd., Bombay, 1970.
45. Zachariah, K.C. and Mitra, A., Internal Migration in India: Rural-Urban Differences in S.E. Asia, UNESCO Research Centre on Social Economic Development in South Asia, Univ. Enclave, Delhi, 1963, pp. 71-76.
46. Desai, P.B, Size and Sex Composition of Population in India, 1901-61, Asia Publishing House, Bombay, 1969.
47. Chandrashekhar, S., Growth of Population in Madras City, Population Review, Vol. 8, 1964.

2

GEOGRAPHICAL SETTING

Study Area

THE STATE of Bihar extends approximately from 22°'N to 27°31'N latitudes and from 83°20'E to 88°17'E longitudes. It has an area of 1,73,876 sq. kilometres (67,196 sq. miles). Among the North Indian States, it is smaller than Uttar Pradesh, Jammu and Kashmir, but it is about double the size of West Bengal and more than triple the size of Punjab. With a population of 5,63,53,369 in 1971, *i.e.*, 10.28 per cent of the national population, it ranks as the second largest State of the Indian Union, the first being Uttar Pradesh. The thickly populated plain region in the northern half of the State has been an important focus of history and culture in India. The State possesses some unique physical, cultural and economic features which have had an important bearing on population growth, pace of industrialisation and extent of urbanisation.

Physical Features

Bihar can be put physiographically into two broad divisions—the vast Ganga plain in the north and the highlands of Chota Nagpur in the south. These two distinct geographical units, one having extensive fertile plains and the other richly endowed with minerals and forests have made their own distinctive contribution to the growth and evolution of urban centres in the State. The former covers about 79,600 sq. kms. or 45 per cent of the State territory and is roughly delimited in the south by 150 m. contour lines (Fig. 2.1). Except for a few isolated hills and hillocks, the entire tract is an alluvial homogeneous plain, being intensively devoted to agriculture. The Ganga divides this plain into two unequal parts. The north Bihar plain is only 250 ft. above the sea level except a small hilly tract (foothills of the Himalayas) in the north-west Champaran district. The other diversities, which are observed on the surface are due to river action—a series of raised riverside uplands known as 'levees' and alternating depression or 'chours' between the streams or along the old

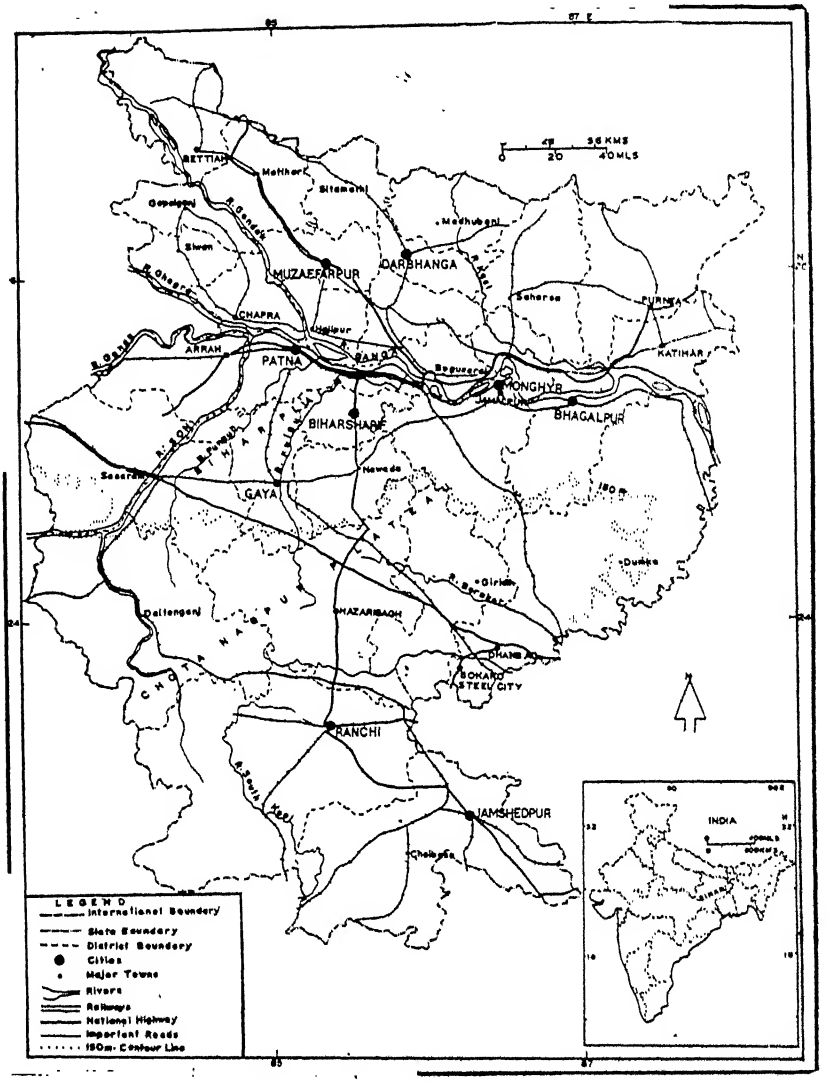

FIG. 2.1 : *Location of Cities in Bihar (1970-71)*

abandoned courses of streams. Foremost of these is the greater development of 'khadar',[1] though most of north Bihar is still 'bhangar'.[2] The Gandak, the Burhi Gandak, the Baghmati, the Kosi, etc., are some of the important streams traversing this plain from north-west to south-east and finally meet the Ganga. These rivers, because of perennial character of their water supply have been very much responsible for evolution and growth of permanent settlements in general and towns in particular. The stable and defensive river banks have been an important consideration in

the siting of towns. At the same time, the parallel courses of streams, lowlands like 'chaurs' and 'tals', annual flood havocs and epidemics have retarded the development of central city.

The south Bihar plain rises more rapidly away from the Ganga than on the north of the river which is ultimately transformed into plateau. The southern plain is characterised by a narrow upland along the Ganga (Levee) and the area adjoining it is a vast lowland country, called the 'Tal' in Patna district. It is liable to flood every year during the rainy season. As we move towards the south, many isolated hills of ancient crystalline rocks rise above the agricultural plain, notable among these being Kharagpur hills (100-1000 ft.) in Monghyr, Pirpahari and Rajgir hills in Nalanda and Barabar hills in Gaya districts. The important tributaries of the Ganga in the south Bihar plain are the Son, the Phalgu, the Punpoon and the Morhar which have their sources in the southern highlands. This entire plain area of Middle Ganga valley has, however, been the cultural and economic heart of India which appears to have been occupied by human settlement deep down during the pre-historic times.[3]

The country south of the 150m. contour line is the hill and plateau region, known as the Chota Nagpur plateau. It covers the districts of Hazaribagh, Ranchi, Singhbhum, Palamau, Dhanbad, Santhal Pargana and parts of Shahabad and Gaya. The hilly south Bihar does not consist of one plateau but it comprises a series of plateaus—Kaimur, Rajmahal, Ranchi, Lower and Upper Hazaribagh plateaus, etc. They vary in altitude from 1500 to 3600 ft. above the sea level. The rugged and undulating terrains have, thus, prevented the growth of large urban communities. The entire Chota Nagpur region abounds in rich mineral deposits particularly coal and iron ore which have been responsible for the birth of a number of urban centres in recent years. The principal streams of Chota Nagpur region are the Damodar, the Subernarekha, the Barakar, the Koel, etc., which have made available adequate water supply for emergence of giant industrial cities of Jamshedpur, Ranchi (Heavy Engineering Corporation) and Bokaro Steel City.

Climatic Features

The State of Bihar is influenced by tropical monsoon climate. Being largely situated to the north of the tropic of cancer the region is put to bear extreme cold in winter and hot in summer. The average temperature in January ranges from 15.5°C in the north to 18°C in the Chaibasa plain[4] in the south. Temperature on the higher altitude of the plateau remains almost the same as in north Bihar. During the summer, the average temperature for May varies from 29°C in the east and north-east of the State to 32°C in the west. Rainfall in Bihar plain is heaviest in the

north-east (Purnea district) where it records over 190.5 cm and decreases towards western border with about 101.6 cm. Mostly north Bihar, north-east of the Burhi Gandak has more than 127 cm rainfall while a small tract in south-west Palamau district receives lowest rainfall in Chota Nagpur region. The rainy season in the State begins from the early June and continues till early October. Thus, the two principal elements of climate, viz., temperature and rainfall are quite ideal and conducive to the growth of agglomerated type of rural and urban settlements.

Agriculture

The economy of Bihar is largely based on agriculture but the increasing importance of industry during recent decades has also played a vital role in the development of the region. More than 80 per cent of its people derive their livelihood from agriculture. Bihar plain with its rich and fertile alluvium has been agriculturally famous since time immemorial. Because of the physiographic character of the plain, its fertile soil and climatic superiority, Bihar occupies a very remarkable position among Indian States with regard to agricultural potentialities. As a result of presence of fertile soil in extensive areas with good seasonal distribution of rainfall, the region has been the centre of population concentration since pre-historic times. At the same time, the total absence of extractive minerals has resulted in an extraordinary pressure of agrarian working forces on land. Because of the predominance of rural economy, even in large urban communities, there is a significant proportion of workers engaged in primary occupations. Patna, for instance, being the largest city in the State with about half a million people, has 15.41 per cent of its working force engaged in agriculture. Similarly other cities in the plain area, viz., Gaya, Bhagalpur, Darbhanga, Muzaffarpur, Monghyr and Biharsharif have considerable proportion of their people dependent on primary activities.

In terms of relation between the land and the input of human labour, the nature and character of farming is intensive. This is indicated by the fact that in no other State of India, the number of agricultural labourer per 100 of net sown area is so high as in Bihar where there are 22 agricultural labourers per 100 acres of net sown area.[5] The Chota Nagpur plateau, on the other hand, is a region of irregular surface and poor soil and is agriculturally less productive than the plain. The land in general is less fertile particularly on the upland tracts and population is less dense than in plains and agriculture is less intensive.[6] Rice is the most important crop in both Bihar Plain and Chota Nagpur plateau followed by a large number of crops like wheat, maize, barley, linseed, millets, sugarcane, etc. In acreage as well as production rice occupies a pre-eminent position amongst the crops of Bihar.

Mineral and Industry

Bihar is the most important mineral bearing State in India which accounts for 40 per cent of its mineral production.[7] This State leads other States in the output of coal, mica, iron ore, china clay and limestone while it is one of the important producers of bauxite, asbestos, feldspar and quartz. Besides, it has very huge deposits of copper, apatite and kyanite.

As regards industry, the State occupies an important position in India. Bihar has now become the leading producer of iron and steel after the installation of Bokaro Steel Plant. Similarly, she is also one of the leading producers of metal copper while it occupies very significant position in the manufacturing of chemical fertilizer. In respect of production of cement and fine clay products, the State has very significant position in India. Bihar is only second to U.P. in the production of sugar in northern India. The exploitation of above minerals and large scale industrial development has been the most important reason for emergence of giant industrial undertakings and subsequently urban agglomerations. Waves of industrialisation have also spread in the plain, with the result, urban communities of considerable sizes have started growing at rapid pace.

Demographic Trends

According to 1971 Census, Bihar had a total population of 56,353,369 which showed an increase of 21.3 per cent (23.6% male and 18.9% female) over 1961 (Table 2.1). During the same decade (1961-71) the growth rate in India was 24.7 per cent. Generally, the population of Bihar has shown a somewhat slower growth rate than the population of India, but she has recorded higher increase than the previous decade (18.80%). The trends

TABLE 2.1 : **Decadal Variation in Population of Bihar (1901-1971)**

Census year	Total population in million	% of decadal variation	Proportion of male per 1000 females	Urban population in million	Percentage of decadal variation
1901	27.3	—	948	1.09	—
1911	28.3	3.67	958	1.07	1.92
1921	28.1	—0.66	985	1.16	9.30
1931	31.4	11.45	1007	1.42	22 00
1941	35.2	12.20	1004	1.90	32.99
1951	38.8	10.27	1010	2.62	37.07
1961	46.5	18.80	1006	3.91	50.94
1971	56 3	21.32	1004	5.63	43.94

Source : (a) Census of India, General Population Table, Bihar, 1961.
(b) Census of India, Primary Census Abstract, Bihar, 1971.

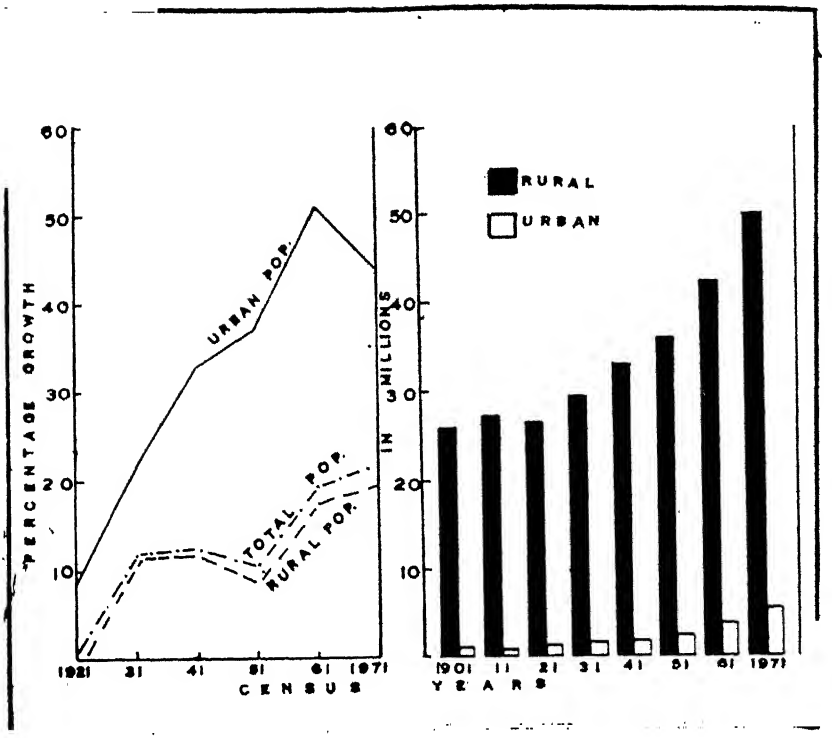

FIG. 2.2 : *Growth of Population (1901-71)*

of population growth was much the same in the last three decades (1941-71) (Fig. 2.2).

Inside Bihar, the districts of Saharsa, Purnea, Hazaribagh, Dhanbad and Palamau showed the highest rate of population increase during 1961-71, as they had shown in the previous decade too.

When the rate of population growth in different districts is compared with the population density in 1971, it becomes obvious that higher growth has been recorded in the areas with moderate to low density and moderate growth in areas with the highest densities (Table 2.2). Patna, Muzaffarpur, Saran and Darbhanga, with the highest densities (between 598 and 632 persons per sq. km.) have growth between 17.56 and 20.58 per cent (below the State average). Dhanbad, with a density of 490, has recorded 25.63 per cent growth. Saharsa and Purnea, which have a moderate density of 339 and 363 persons respectively, experienced the highest growth. Palamau, with the lowest density registered a growth of 26.69 per cent followed by Hazaribagh, Shahabad, Bhagalpur, Ranchi

TABLE 2.2 : **District-wise Growth of Population in Bihar (1961-71)**

State/Districts	Percentage increase of population			Density persons/ sq. km. (1971)	Change in % of urban population	L.Q. of population growth (1961-71)
	Total	Rural	Urban			
Patna	20.58	18.13	35.00	632	2.41	0.97
Gaya	22.18	21.86	22.70	360	0.35	1.04
Shahabad	22.41	22.38	39.60	381	1.02	1.05
Saran	19.36	19.36	20.00	610	0.01	0.91
Champaran	17.86	17.54	26.70	388	0.38	0.84
Muzaffarpur	17.56	16 92	34.30	622	0.66	0.82
Darbhanga	18.60	18.47	21.20	598	0.11	0.87
Monghyr	14.93	14.18	23.20	475	0.77	0.70
Bhagalpur	22.21	21.93	18.20	370	−0.29	1.04
Saharsa	36.25	35.64	57.90	337	0.60	1.78
Purnea	27.61	26.73	34.60	363	0.33	1.30
Santhal Pargana	19.14	18.67	28.40	226	0.43	0.90
Palamau	26.59	26.59	25.60	119	0.04	1.25
Hazaribagh	26.04	21.64	93.30	173	4.48	1.22
Ranchi	22.06	21.89	76.20	142	4.20	1.03
Dhanbad	25.63	13.11	120.00	490	18.50	1.24
Singhbhum	18.92	14.17	45.10	181	4.75	0.89
Bihar	21.31	19.72	43.90	324	1.56	—

L.Q.=Location Quotient is the ratio between percentage of two types of distribution in an area.

Source : Op. cit.

and Gaya. In the densely populated area, additions of a large number of people results in a lower percentage growth while in areas with sparse population, addition of a small population may result in a high percentage increase. Secondly, it may be as a result of the exodus of people from densely settled areas which operates in two ways—firstly, from densely settled rural areas to economically attractive rural areas having sparse population; and secondly, from densely settled rural areas to the growing urban centres.

The pattern discerned with the help of locational quotient of population growth during 1961-71, gives almost the same picture as that of percentage change. Almost all the areas having high density have low L.Q. values which suggests low population growth in these districts, viz., Patna (0.97), Saran (0.91), Muzaffarpur (0.82) and Darbhanga (0.87). The highest growth of population in Saharsa and Purnea well corresponds with the fast growth of the districts after the taming of the Kosi river, eradication of malaria and other diseases and subsequent improved

agricultural practices.[8] The exceptionally high rate of increase is further explained by a very high percentage of Muslims (38% in Purnea in 1961) who came as a result of the communal disturbance after the partition of the country in 1947. Eventually disillusioned, most of them returned from Pakistan as reflected in 27.61 per cent growth of population in Purnea during 1961-71 and even higher growth in Saharsa.[9]

The higher growth of population in the districts of Chota Nagpur is chiefly due to high immigration on account of stepping up of the forest, setting up of numerous industries and exploitation of various minerals resources. Likewise, the lowest growth in Monghyr may be the result of large scale emigration of rural population to the neighbouring districts of Saharsa.

The proportion of urban population of Bihar in 1971 (as in 1961) was the lowest among the States of India, except Orissa and Assam, it being 10.04 per cent against all India's 19.87 per cent. Urban population in Bihar had increased from 8.4 per cent to 10.04 per cent during the decade 1961-71 against the all-India increase of 10.0 per cent to 19.87 per cent during the same decade. Within the State, urbanisation is the highest in the industrial belt of Chota Nagpur especially in the district of Dhanbad, Hazaribagh, Ranchi and Singhbhum where the percentage of urban population has increased from 4.48 per cent to 18.50 per cent. Dhanbad recorded the maximum growth (120.0%), followed by Hazaribagh (93.3%), Ranchi (76.2%) and Singhbhum (45.1%). The agricultural regions of the plain experienced relatively low growth in their urban population (between 18.8 and 28.4%).

TABLE 2.3 : **Demographic Features of the Cities in Bihar (1971)**

Cities	Percentage of Total Population			Sex ratio
	Workers	Literacy	S. Castes & S. Tribes	(Females per) 1000 males)
Patna	27.19	53.75	8.58	794
Jamshedpur	28.81	56.62	11.45	795
Ranchi	26.69	59.30	17.32	806
Gaya	25.07	47.84	8.52	844
Bhagalpur	25.55	47.29	6.61	809
Darbhanga	25.03	43.52	10.90	844
Muzaffarpur	27.29	50.48	7.54	743
Monghyr	21.96	45.48	6 49	844
Biharsharif	26.04	39.01	9.32	873

Source : Census of India, General Population Tables (Bihar) Series 4, Part—II, A, 1971.

The other noticeable demographic trend towards the masculinity of population in Bihar which had manifested itself after the census of 1921, has been pronounced during 1961-71, when the number of females per 1,000 males came down from 994 in 1961 to 956 in 1971. As Kerala is the only State in India where females outnumbered males (1971), so Saran is the only district in Bihar where females exceeded males in number. The masculinity of the population is all the more remarkable in Bihar which sends out large number of emigrants, mainly males to other States of India. In striking contrast to the adverse sex ratio in urban areas, the rural areas of Bihar have quite favourable sex ratio (953). Similar position obtains in as many as 13 out of 17 districts of the State. Even in others with the exception of Dhanbad, the rural sex ratios are not too adverse in any district. The urban area of the State has an extremely adverse sex ratio. There is no district in Bihar which has a favourable sex ratio in urban population. The position is most acute in urban areas of Dhanbad, Palamau, Purnea and Singhbhum. Even in the urban Bihar there are considerable variations in the sex composition from district to district and town to town. The cities and town groups having population over one lakh or more have the most adverse sex ratio (Table 2.3). This is to be expected for such large urban centres which contain the largest concentration of non-agricultural workers, immigrants and students (Fig. 2.3). The most important reason of such sex imbalances in urban population is that the job migrants initially seldom bring their families with them owing to scarcity of houses and other difficulties.

As against an overall literacy rate 51.2 per cent in the urban population of Bihar, the corresponding ratio in the rural population is only 19.9

TABLE 2.4 : **Occupational Structure of the Cities in Bihar (1971)**

Cities	Percentage of total workers						
	Agriculture	Mining and industry	Trade and commerce	Transport and communication	Construction	Other services	Total
Patna	15.42	15.85	20.91	8.74	3.38	35.70	100
Jamshedpur	4.10	57.60	12.41	7.43	4.12	14.34	100
Ranchi	6.85	34.06	19.38	9.70	2.39	27.62	100
Gaya	10.69	19.29	25.45	13.94	3.29	27.34	100
Bhagalpur	12.45	29.29	21.89	8.32	1.77	26.28	100
Darbhanga	15.45	18.26	24.20	9.02	3.26	29.82	100
Muzaffarpur	11.42	15.59	27.97	9.67	4.32	31.03	100
Monghyr	16.53	25.94	19.74	9.38	2.13	26.28	100
Biharsharif	23.36	30.87	22.03	5.13	2.68	15.93	100

Source : Op. cit.

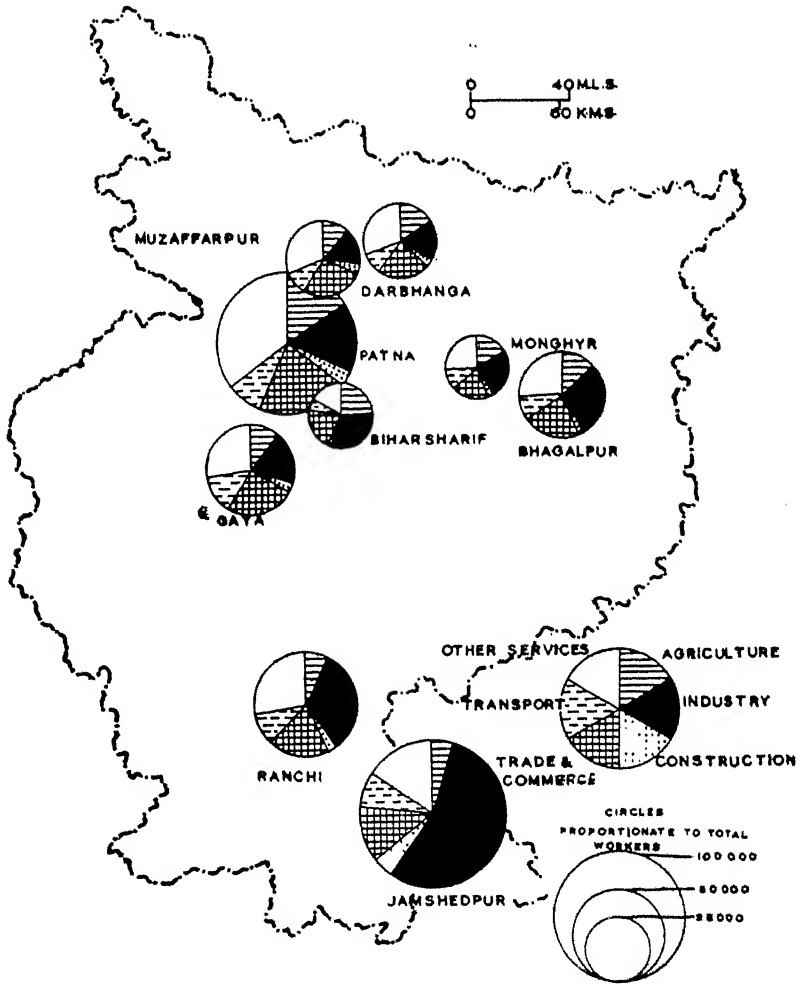

FIG. 2.3 : *Occupational Structure (1971)*

per cent. Thus, the urban population of the State has nearly three times more literacy than the rural population. Among the districts of Bihar, Champaran and Palamau continued even in 1971 to be the districts with the lowest literacy. In urban areas, further, literacy is much higher in cities than small towns because of greater facilities of education. In addition, the Table 2.4 exhibits in detail the functional characteristics of the cities in Bihar.

Impact of Physical and Economic Factors on the Growth of Cities

Physiographic features have direct bearing on the growth and development of human settlements and their occupations. Bihar Plain with immense agricultural potentialities has always been attractive for growth of agglomerated settlements. The homogeneous fertile plain combined with network of dendritic pattern of drainage and monsoonic climate have made the human civilization to flourish in this region since time immemorial. This feature has greatly affected the economy and socio-economic and cultural life of the State. The fertile plain is traversed by a number of perennial streams, which have acted as a centripetal force for the settlements in general and towns and cities in particular. The parent stream Ganga traverses the plain through its centre and large number of tributaries like the Ghaghra, the Gandak, the Burhi Gandak and the Baghmati come from the north. Out of 106 towns and cities scattered over the plain, almost all of them are situated along some important rivers. The stable and defensive banks of rivers have helped the growth of urban settlements by providing them a permanent site. In ancient days, water front has been very attractive site for the location of towns and cities. Nowhere the role of rivers has been so important in the evolution of towns as in Northern India.[10] Rivers of this part of the State are also the site of many towns and cities. Of the nine large cities (over 100,000 population) seven of them are clustered in the central plain, mainly along the important rivers. In this way, cities like Patna, Monghyr and Bhagalpur have their locations along the high 'levee' of the Ganga. The site of other cities like Darbhanga, Muzaffarpur, Gaya and Biharsharif have been the banks or dry points above flood level of the little Baghmati, the Burhi Gandak, the Phalgu and the Panchane respectively. Apart from these, there are a large number of medium and small size towns like Chapra, Hajipur, Begusarai, Samastipur, Madhubani, Danapur, Colgong, etc., which are situated along the course of streams. The existence of these urban communities in the Central Bihar plain seems to bear a much closer relation to the density of population (Fig. 2.4).

Before the advent of modern means of communication, the rivers were the main highways for trade and commerce in the plains. The location of riverside cities was helpful to get abundant water supply and favourable for religious conviction. Defence was also an equally important consideration in the location of towns in the past. Thus, the river bluffs or some prominent 'levees' provided commanding sites for the development of fort cities.[11] As a source of water supply for human beings, livestock and industries, the rivers are of utmost importance in Chota Nagpur plateau region which is rock country with uncertain and limited underground water.[12] Water supply in the two largest urban centres of Chota Nagpur, e.g., Jamshedpur and Ranchi, is largely made through dammed reservoirs

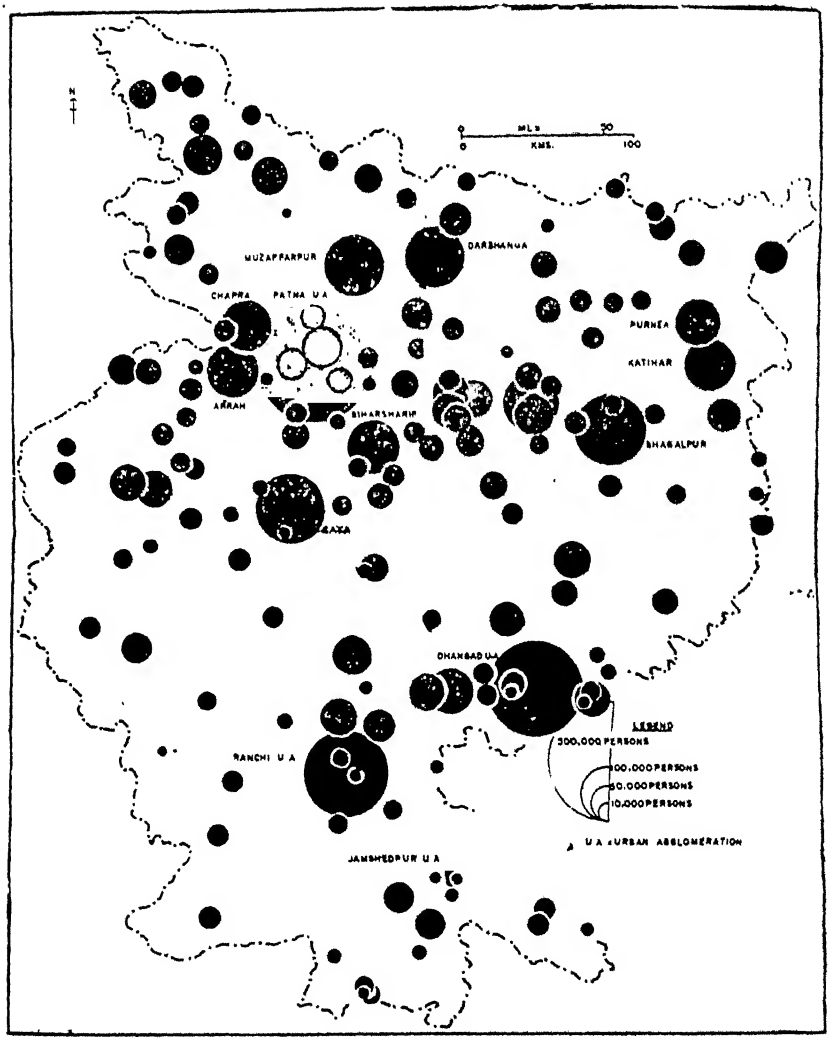

FIG. 2.4 : *Distribution of Urban Places (1971)*

capable of supporting their industrial and urban population. In view of the above reasons, riverside location of towns in Chota Nagpur may be considered not merely deliberate but natural and inevitable. In this way, the riverside location both in the plains and the plateau is most common. All the nine cities in Bihar are on sizable rivers whose banks appear to have formed the original focus of urban settlements.

In contrast to the Bihar plains the highlands of Chota Nagpur are characterised by poor cultivation and sparse population. The entire Chota

Nagpur region abounds in rich mineral deposits particularly coal and iron ore. In addition, the development of power—both thermal and hydel speeded up the progress of industrialisation. The majority of urban centres in Chota Nagpur are, therefore, raw material zone towns which owe their location to the mineralised areas in which they occur. Towns of the Lower Damodar Basin, viz., Dhanbad, Jharia, Bermo, Sindri, Patherdih, Kargali, Bhojudih, etc., are perched on the coal-field of the valley. Giridih, Tilaiya and a number of others have come into prominence as a result of high degree of specialisation in mica processing. Numerous large and small urban centres in the Subernarekha basin such as Ghatsila, Mosabani, Dhobani, Gua, Badampahar, Noamundi, etc., have come into existence based on copper and iron ore mining. Out of 96 towns of different sizes, majority of them are clustered in Damodar and Subernarekha basins.

Apart from these, the growth of cities in modern times is also taking place as a result of improvement of means of communication lines. Large cities are today the centres of transport where roads and railways from different directions converge. Thus, from the location point of view, numerous cities and towns have an unusual nodality of roads and railways. Such are the cities of Patna, Jamshedpur, Gaya, Muzaffarpur, Darbhanga, Biharsharif, Chapra, Samstipur, etc. The steel city of Jamshedpur is a remarkable example of nodality where railways from the mineralised upper and the industrial lower Damodar basin, from Bombay and Calcutta, from iron mines of Bihar and Orissa, and roads from all sides, converge at the junction of Subernarekha and Kharkai. This kind of centrality may be observed in many other cities of Bihar.

Theoretical Views regarding Location of Cities

A fundamental geographical question is : what are the causes of the existence, present size and character of a city? This subject has largely been taken up by Western geographers and economists who in the light of the existing environmental condition have put forward different concepts and propounded various theories. No theory, however, seems to be of universal application. The first theoretical idea of modern importance was initiated by Von Thunen[13] who postulated the existence of an entirely uniform landscape and showed that under ideal conditions a city would develop in the centre of this area. Kohl[14] studied the relationship between cities and the natural and cultural environment, paying particular attention to the effect of transport routes on the location of urban centres. Cooly[15] investigated the causes for the location of cities in which he elaborated the concept by saying that though cities in the past were located by proximity to a religious establishment or a fort while some others have all the times been located by political considerations, the primary reason for location of cities are found in transportation. Weber[16] supporting the view of Cooly also enquired into the causes of the concentrations of people

into the cities and concluded that this was primarily a product of economic, political and social forces. According to Haig,[17] a large concentration of people and manufacturing takes place at a point where assembly of raw materials is cheapest. Mekenzie[18] was also inclined to accept a similar view at least for some periods in the process of American urbanisation. A detailed theoretical framework for the growth and distribution of urban settlements was provided by the work of German scholar, Christaller.[19] His basic assumption was that a given rural area supports an urban centre which in turn serves the surrounding countryside. There are smaller towns for smaller areas and bigger cities for larger regions. This concept permitted Christaller to build up an integrated system of cities according to their size. If this theory were correct, the cities in a given area would have to be evenly spaced. This is exactly what Christaller claims at least for west European cities.

In a subsequent work, Losch generalised the concept in several respects and made it more applicable. The practical application of the central place theory of Christaller and Losch is limited on several grounds. Firstly, the theory requires special natural surroundings which are not universally found; secondly, it is based on highly ideal and imaginative principles; thirdly, the land for the growth of cities must be homogeneous with equal economic potentialities and lastly, the region must be economically balanced in all respects. The question of applying this concept in a region like Bihar having extreme physiographic and economic disparities, therefore, does not arise.

In the light of the above theories, if we examine the pattern of growth and distribution of the cities in Bihar, political, economic and social forces have always been responsible for their growth. Administration as a matter of fact forms the backbone of Indian urbanisation. Since time immemorial administrative set-up has played a vital role in the establishment of capital cities.[20] In early days, local *rajas, subedars* and chieftains very often selected stable and defensive sites, usually on river banks on which lofty fortifications were erected. In medieval period, Muslim emperors used to establish such fortifications at the seat of their administration which ultimately grew into modern cities.[21] The eastern part of Patna may be cited as an example which passed through several vicissitudes of the historical past and retains the ruins of ancient fortress. In Muzaffarpur, Darbhanga, Bhagalpur, Monghyr and Biharsharif, there are remains of ancient forts. The growth of cities in modern times is largely based on the improvement of means of communication and development of mining and industry.

Antiquity of the Cities in Bihar

In order to understand the causes of growth of the cities and their present sites, it is imperative to probe the history and process of growth of these

cities. In the ensuing paragraphs an attempt has been made to study the antiquity of these cities so as to make an appraisal of their growth before and after the advent of the British rule. Industrialisation, a recent phenomenon has largely been responsible for modern trends of growth of a few cities in the State.

Patna (25°34'N lat. and 85°12'E long.) : Patna is one of the most ancient cities of India. Patliputra, as it was called during historical period, was the capital city of Magadh. It was situated at the confluence of the Son and the Ganga where the existing settlement was Patligram.[22] This village (Patligram) was fortified by the king Ajatsatru (494-467 B.C.) and later his grandson Udaya (443-418 B.C.) founded the city of Kusumpur within the fortress. The two sites soon merged together and developed under the Maurya king Chandragupta as the great Metropolitan city of Patliputra[23]. Emperor Ashok, the grandson of Chandragupta ascended to the throne in 272 B.C. and built a stone palace which was also in existence in the first decade of the 5th century A.D. After the death of Ashok, the city decayed for a while, while its history went into oblivion. But during the reign of Gupta in the 4th century, the town once again came into prominence as a capital city. The city declined in importance after the fall of Guptas dynasty. The Chinese pilgrim Hiuen Tsang who visited the city in about 637 A.D. remarked "the monasteries, Deva temple and 'lopes', all were in a state of ruin." The city during Muslim periods owned its pre-eminence due to its commanding position on the Ganga within a few miles of the confluence with this river of the Son, the Ganga and the Gandak.[24] In 1541, Sher Shah established his capital at Patliputra and once again the city became a bustling centre of trade and commerce. He also built a magnificent fortress of which the *Pachim* and *Purab Darwajas* are the two important remains even today. The city is said to have reached at its peak during the reign of Azim-us-Shah, the grandson of Aurangzeb and thereafter followed a period of stability and by the middle of the eighteenth century the English people came on the scene. The city within the walls was rather more than a mile and a half from east to west and three quarters of a mile from north to south and was exceedingly closely built.[25] Britishers extended the city far beyond the fortified walls and development took place along the river bank as far as the administrative complex to the west.

Through the centuries, Patna witnessed rise and fall of many emperors and became the provincial capital of Bihar and Orissa in 1911-12. Subsequently, huge construction work laid out towards west of Patna-Gaya road which now contains *Raj Bhawan*, Old Secretariat, Patna High Court, residences of Judges and ministers and other officials. The establishment of Patna University in 1919 created the cultural focus in the city.

In the post-Independence period administrative and commercial activities in the city increased manyfold which led to sprawl of the city to its present extent. The city expanded in a linear fashion parallel to the Ganga as the land immediately behind the 'levee' is low and liable to flood. With the construction of the protection embankment (New Bypass) in the south, the city has extended to a limited extent.

Jamshedpur (22°47'N lat. and 86°12'E long.): The history of origin of the steel city of Jamshedpur is much more recent than other cities in Bihar. The story of its birth goes back to the later part of the first decade of the present century when a group of engineers commissioned by the House of Tata after a long search, laid the foundation stone in 1907 at an Adivasi hamlet called Sakchi. The city has a picturesque location at the confluence of two rivers – the Kharkai and the Subernarekha in an undulating plateau, surrounded by the rugged hills of Chota Nagpur. The choice of the village Sakchi was guided by the fact that it was within easy access of iron ore, flux and coal, it had a perennial supply of water. It was also adjacent to the Kalimati railway station, which is on the main railway line connecting Bombay and Calcutta.[26]

The location of Jamshedpur with respect to transport and communication and also raw materials was, thus, most economical. The first township appeared in the Census of 1911 in the name of Sakchi with a mere 5,672 persons. The subsequent decade was marked by a gigantic rise of population (57,360) due to large scale immigration. The people came to work in the industries owing to the expansion of the TISCO and commencement of erection of other associated factories in the city. Besides, numerous offices and retail services started functioning as an immediate requirement for the neighbourhood. As the steel works and town expanded and the ancillary industries started functioning, each with its own workers' colonies, problems of civic administration of the city started cropping up. The most remarkable feature in the development of Jamshedpur was that the city expanded areally strictly on the basis of planning. In 1920, Fredrick Charles Temple, a sanitary engineer to the Government of Bihar was engaged as the chief town engineer. In 1936, P.C. Stockes and in 1943, Otto Koeningsberger were employed to make an extensive study of the existing conditions and draw up an extensive master plan for the future requirement of the city.[27] During the last few decades, Jamshedpur because of rapid industrialisation, was made a large urban sprawl beyond the existing city limit. With the result several satellite townships such as the Adityapur, Bagbera, Kalimati, Jugsalai, etc., have emerged at the city suburb which could turn the city into the largest urban-industrial complex in Bihar. The modern planned city of Jamshedpur expanded enormously in different phases of growth of industries which reflected sectoral development patterns. The city population of 57,360 in 1921

shot up to about half a million in 1971 giving it a rank second only to Patna.

Ranchi (23°23′N lat. and 85°20′E long.): The earliest nucleus of the present Ranchi city was the *Purana* Ranchi, situated at the foot of Ranchi hill. On the creation of the S.W. Frontier Agency in 1834, Captain Wilkosin selected the hamlet Kishenpur as his headquarters and to avoid confusion with other places of the same name, the station after a few years, was designated as 'Ranchi' after the hamlet 'Purana Ranchi'.[28] The place started growing with the shifting of the headquarters of the Principal Assistant from Lohardaga to Ranchi in 1848 and creation of the post of Deputy Commissioner in the subsequent year.[29]

The advent of the Christian missionaries in Ranchi (1845) was an important landmark in the history of development of the city. The first war of Independence (1857) caused a temporary setback to the spread of Christianity but in subsequent years the missionary activities made rapid strides in converting the tribals to Christianity. The Municipality of Ranchi came into being in the year 1869 with an area of 7.22 sq. miles which gave attention to the improvement of the traditional weekly market and other civic amenities. After the Congress Ministry came in power (1952), a large number of construction works took place and the city became the summer capital of the State and administrative headquarters of Chota Nagpur Division and also of Ranchi District.[30]

The city, located on the central plateau at an elevation of 2128 ft. above the sea level is today the third largest city in the State. The establishment of university headquarters, Ranchi grew considerably in area as well as population. Similarly, the creation of the headquarters of the National Coal Development Corporation, the Heavy Engineering Corporation and the Hindustan Steel Limited boosted the growth of the city in various directions. Ranchi incorporated growth pattern almost typical alike other traditional cities in the State. The population of the city was 1,40,253 in 1961 which rose to 2,55,551 in 1971 along with its constituents together forming Ranchi urban agglomeration.

Gaya (24°47′N lat. and 85°0′22″E long.): The city of Gaya has a great antiquity. It finds mention even in the early Hindu mythological literature. The name of Gaya according to *Bhagwat Purana* owes its origin to a Demon king, Gayasur, who dwelt in the town in *Treta Yuga*[31]. Archeological discoveries point to its existence in the 6th century A.D. It is one of the holiest spots for the Hindu and has been an important religious centre drawing pilgrims from all over the country. Situated only eleven kilometres south from Gaya town is Bodh Gaya, the holy place for the Buddhists. It is believed that Lord Buddha achieved Nirvana or enlightenment at Bodh Gaya.

The initial stage of development of the city was followed by the

erection of a large number of religious temples of the Sun, Gadadhara, Shiv, Parvati and other gods and goddesses. Thus, a small but important fortified religious nucleus around Vishnupada came into existence. Under the British rule, the built-up area expanded largely in Sahebganj between the old town and the Ramsila hill. Buchanan has mentioned the morphological features of the old or Andar Gaya as narrow, dirty and crooked streets but large houses which were built to form continuous barrier.[32] The place, however, turned from a small religious uncleus into a large urban sprawl amidst temple crowned hills. Rapid development followed with the construction of administrative offices, educational institutions, etc., when Gaya became the district headquarters in 1825. The nodal character of the city with the construction of railway lines from all directions led to a growth of industrial and commercial activities in the post-Independence period. With an area of 7,585 acres, the city accommodates 1,79,884 inhabitants according to 1971 Census.

Bhagalpur (25°15′N lat. and 87°02′E long.): The history of origin of Bhagalpur dates back to the medieval period when Akbar's troop marched through this place while invading Bengal in 1573-75 A.D. In the famous book Ain-i-Akbari, Bhagalpur is mentioned as the chief town of *mahal* or *pargana* Bhagalpur.[33] However, the present site of the main city was once occupied by a miserable straggling collection of huts, extending over a few miles and was divided by fields, gardens and plantations. Immediately west of this place, was the old Karnagarh fort which accerding to Hindu mythology was built by the king Karna of the epic Mahabharata. Champanagar and Nathnagar, the two contiguous settlements which form today the part of the city, were the old nucleus from where the city spread eastward. Until 1869, Bhagalpur was not only very important town while Nathnagar and Champanagar had not only a large population but a sizeable trade and commerce. Apparently the growing importance of Nathnagar and Champanagar led to the sprawl of the city towards east and the present city consisting of huts and gardens started developing.

Bhagalpur was constituted Municipality in 1864 which provided communication and drainage facilities for the growth of the city. The location of '*Fauzdari*' and '*Diwani*' *Adalat*[34] in Bhagalpur accelerated the growth of the town during British period and in a few decades Bhagalpur became much more important than Nathnagar and Champanagar. Besides, because of the development of weaving industry, the city became an important centre of trade of cottage products. Being the administrative headquarters of both Bhagalpur Division and District, the city has a large number of Government offices of different levels. The establishment of the University in Bhagalpur further raised the prospect of growth.

Darbhanga (26°10′N lat. and 85°54′E long.) : Extending north-south along the little Baghmati river, Darbhanga is the largest city in North Bihar Plain and has been important since pre-historic times. In ancient time, the place was the headquarters of the old kingdom of Mithila. It passed successively under the Pal and Sen dynasties. Later, from the middle of the fourteenth century it was ruled over the Brahmin kings. Besides, the city had to face a number of invasions by Muslim emperors. At one time, it was also known as Dwar-i-Bengal, i.e., the gate of Bengal.[35] The name of the city was also probably derived after a Mohammedan trader named, Darbhangi Khan of which little or nothing is known.[36] The most conspicuous feature of the city is the existence of a number of tanks about which there are different opinions among Hindus and Muslims.

In modern times, the only landholders of any historic significance is the Maharaja of Darbhanga who has a vast area laid out with most astonishing fortifications. Since then, Darbhanga has been growing remarkably. The city besides being the district headquarters has also become the seat of higher learning with the establishment of Mithila University headquarters.

Muzaffarpur (26°7′N lat. and 85°24′E long.) : Muzaffarpur is the administrative headquarters of both the Tirhut Division and Muzaffarpur District. The city has been important since the eighteenth century when the place was simply a collection of overgrown villages, ruled over by Muzaffar Khan, a farmer of Chakla Nai *pargana*. The city came into prominence and started rapid development since 1895 when Tirhut was divided and Muzaffarpur became the headquarters. Formerly, the town was liable to inundation and its growth was restricted, but when the place was brought under Municipality, the calamity was removed by constructing (Daudpur) protection embankment.

In the present century, the city has grown enormously in both area and population. With the linking up of north and south Bihar through the rail-cum-road bridge at Mokameh (1959) the city has become one of the most important urban centre in north Bihar. Another reason of its growth is adequate facility of transport and communication and Muzaffarpur is the Divisional headquarters of railway. Besides, the city is a very large commercial centre particularly of wholesale trade in cloth and foodstuffs. Recently, the city has become the seat of headquarters of Bihar University which has considerable bearing on the areal and demographic changes of the city.

Monghyr (25°23′N lat. and 86°28′E long.) : The city located on the bank of the Ganga is one of the ancient urban centres in Bihar and even it finds mention in the great epic Mahabharat. "It is noted that both Ramchandra and Lakshmana on their way back from the encounter with Tarka, the demons, took rest at the spot, the relaxation they had, gave rise to the name of Kastaharni (present Kastharni Ghat) from relaxation".[37]

Monghyr is also said to be the capital of Anga during the reign of the king Karna. Some people are of the opinion that existing fort was initially built by Jarasandha.[38] From these and other references, it becomes clear that Monghyr is a pre-historic city. During historical periods, Monghyr passed through the hands of several Hindu and Muslim emperors and the city continued to be an important place both strategically and commercially. The river front city of Monghyr was, thus, fully exploited for these purposes.

The modern city of Monghyr is an important administrative and industrial centre in South Bihar Plain. Besides being a district headquarters, it is one of the largest manufacturing centres of cigarette and gun in India.

Biharsharif (25°12'N lat. and 85°31'E long.) : Biharsharif is an important historical city and it has been in existence since pre-historic times. The city, located on Bakhtiyarpur-Rajgir railway line had largely come into prominence during Gupta period (413-55 A.D.) and even there stands the ruins of the ancient fort. The ancient Nalanda, was one of the most prominent centres of higher learning (more than 1,000 years ago) and the ruined remains still bear witness to its existence. "Biharsharif town is a very large scattered place surrounding the ditch of an ancient city, now in a great measure deserted".[39]

The city is now the headquarters of Nalanda district and has become an important centre of transport, trade and commerce in Bihar. Because of setting up of a number of educational institutions, Biharsharif has flourished considerably and has become a regional central place with over one lakh inhabitants.

REFERENCES

1. Techno-Economic Survey of Bihar, Asia Publishing House, Bombay, 1959, Vol. I, p. 3.
2. Spate, O.H.K., India and Pakistan, A General and Regional Geography, Methuen & Co Ltd , London, 1954, p. 515.
3. Singh, R.L. and Singh K.N. (ed.), Middle Ganga Plain in India: A Regional Geography, National Geographical Society of India, Varanasi, 1971, p. 184.
4. Ahmad, E., Bihar: A Physical, Economic and Regional Geography, Ranchi University, Ranchi, 1965, pp. 46-47.
5. Ahmad, op. cit., p. 134.
6. Diwakar, R.R. (ed.), Bihar Through the Ages, Orient Longman, Bombay, 1959, pp. 38-39.
7. India: A Reference Annual, Ministry of Information and Broadcasting, Government of India, 1975, p. 314.
8. Kumar, A., Pattern of Internal Migration in Bihar, Jour. of N.E. India Geographical Society, Vol. II, 1970, p. 184.

9. Prasad, S.D., Census of India, 1961, Bihar, Vol. II, Part-II, p. 282.
10. Rizvi, S.Q.A., Role of Rivers in the Evolution of Urban Centres, Geographer, Vol. 9, No. 4, 1957, p. 45.
11. Sinha, K.K., The Growth of Towns Along the Ganga in Bihar, Transaction of the Council of Indian Geographers, Vol. 5, 1968, p. 47.
12. Ahmad, E., op. cit., p. 242.
13. Quoted by Ullman, E., "A Theory of Location for Cities", in H. Mayor and C.F. Kohl (Eds.), Readings in Urban Geography, Central Book Depot, Allahabad, 1967, p. 202.
14. Ibid., p. 202.
15. Quoted by Weber, M., The City, Heinemann, London, 1960, p. 16.
16. Weber, Adna Ferrin, The Growth of Cities in the 19th Century, Macmillan, New York, 1899, p. 51.
17. Ibid., p. 202.
18. Mckenzie, R.D., Metropolitan Community, New York, 1933, p. 4.
19. Christaller, W. (translated C.W. Baskin), Central Places in South Germany, Prentice Hall, 1966.
20. Ahmad, E., Distribution of Cities in India and Pakistan, Geographical Outlook, Vol. I, 1956, p. 3.
21. Davis, K., op. cit., p. 127.
22. Master Plan for Patna, Patna Improvement Trust, 1962, p. 111-15.
23. Bhattacharya, S., Dictionary of Indian History, Calcutta University, 1967, pp. 672-73.
24. Census of India, Bihar and Orissa, Part I (Report), 1931, pp. 88-89.
25. Buchanan, F., Bihar and Orissa, The Bihar and Orissa Research Society, 1811-12, p. 122.
26. Choudhary, Roy, P.C., Singhbhum: District Gazetteer, Secretariat Press, Govt. of Bihar, Patna, 1958, p. 303.
27. Adityapur-Jamshedpur, Draft Master Plan, Town & Country Planning Organisation, Government of Bihar, 1968, pp. 11 and 35.
28. Ranchi: District Gazetteer, Bihar and Orissa, 1917, p. 253.
29. Greater Ranchi, Draft Master Plan, Published by the Ranchi Improvement Trust, 1965, p. 13.
30. Ranchi, District Census Handbook, Census of India, published in 1961, p. lxi.
31. Gaya: A Draft Master Plan, Improvement Trust, Gaya, 1965, p. 1.
32. Buchanan, H., Patna-Gaya Report, An Account of the District of Bihar and Patna, Bihar and Orissa Research Society, 1811-12, Vol. 1, p. 95.
33. Choudhary, Roy, P.C., Bihar District Gazetteers, Bhagalpur, Secretariat Press, Patna, 1962, pp. 598-605.
34. Diwakar, R.R. (Ed.), Bihar Through the Ages, Orient Longman, Bombay, 1958, p. 45.
35. O'Malley, L.S.S., op. cit., p. 92.
36. Choudhary, Roy, P.C., Bihar District Gazetteer, Darbhanga, Secretariat Press, Patna, 1968, p. 5.
37. Choudhary, Roy, P.C., Bihar District Gazetteers, Monghyr, Secretariat Press, Patna, 1960, pp. 31-37.
38. Op. cit., p. 45.
39. Op. cit., p. 170.

3

GROWTH OF POPULATION IN THE CITIES OF BIHAR

THE MOST conspicuous feature of today's population growth is accelerated growth of urbanisation. In several decades of history, population and cities have been growing but the tempo and dimension of recent years have never been equalled. The increase in the number and size of cities is closely associated with the economic development of the region and subsequent shift towards preponderence of employment in secondary and tertiary activities.[1] As is the case with India as a whole, the State of Bihar is experiencing a population explosion and a rapid urbanisation. The total population of the State during the seventy years (1901-71) has increased by 106.33 per cent and the 1961-71 decade alone has registered an increase of 21.32 per cent. This trend has largely been accompanied by phenomenal growth of urban population. During these decades, urban population in Bihar multiplied by more than five times (an increase of 414 per cent) and the last decade (1961-71) recorded a growth of 43.94 per cent. Thus, over 56 lakh urban dwellers are residing in 203 towns of various sizes and classes in different parts of the State. Very often, urban population of a country or a region is largely concentrated in a few large cities or widely distributed in small and medium size towns. In spite of the emphasis being given to industrial and agricultural developments since the country attained independence, the State has only 10 per cent of its population living in urban areas. This is low in comparison with the neighbouring States (U.P.—14.0%, M.P.—16.28%, West Bengal—24.72%) but the trend is one of acceleration in every decade. Of the 56.33 lakh urban dwellers in 1971, 20.15 lakh or 35.78 per cent urban dwellers in 1971, lived in cities[2] and the remaining 64.22 per cent in towns of smaller size. By comparison, 19.87 per cent of the total population of India lived in 3124 towns and cities, of which 52.41 per cent were found to be concentrated in 150 cities (places of 100,000 persons or more). The cities in Bihar have entered a period of rapid growth reflecting

the State's general population increase and rising employment in secondary and tertiary activities.[3]

TABLE 3.1 : **Decennial Growth of Urban Population in Bihar (1901-71)**

Census year	Population of cities	Population of towns	Urban population	Rural population	Total population
1901	1,34,785	9,62,200	10,96,985	2,62,14,880	2,73,11,865
1911	1,36,153	9,41,733	1,77,886	2,72,36,395	2,83,14,241
1921	1,19,976	10,45,949	11,65,925	2,69,60,750	2,81,26,675
1931	1,59,690	12,62,681	14,22,371	2,99,24,737	3,13,47,108
1941	4,67,033	14,34,069	19,01,102	3,32,69,738	3,51,70,840
1951	8,86,718	17,39,543	26,26,261	3,61,55,010	3,87,82,271
1961	13,39,910	25,74,010	39,13,920	4,25,33,537	4,64,47,457
1971	20,15,958	36,18,008	56,33,966	5,07,19,403	5,63,53,369

TABLE 3.2 : **Percentage Decade Variation of Urban Population in Bihar (1901-71)**

Census year	Percentage variations of cities population	Percentage variations of town population	Percentage variations of urban population	Percentage variations of rural population	Percentage variations of total population
1901-11	1.01	3.50	−1.92	3.90	3.67
1911-21	−11.88	6.79	9.30	−1.04	0.66
1921-31	33.10	4.76	22.00	10.99	11.45
1931-41	192.58	27.27	32.99	11.21	12.20
1941-51	89.86	34.52	37.07	8.75	10.27
1951-61	81.10	35.48	50.94	17.54	19.77
1961-71	50.45	32.02	43.94	19.23	21.32

Source : Data have been compiled from :
(a) The Census of India, Bihar, General Population Table, 1961.
(b) The Census of India, Series-I, Paper-I, 1972, pp. 85-88.

An analysis of data reveals that population of the cities with respect to the total urban population in Bihar increased from 12.29 per cent in 1901 to 35.78 per cent in 1971 whereas the population of the cities with respect to the total population rose from 0.49 per cent in 1901 to 3.22 per cent in 1971.

Considering the decennial percentage variations of the cities population in Bihar during the last seven decades, it is noteworthy that there has been a regular and remarkable increase in the percentage of city dwellers. Tables 3.1 and 3.2 reveal that the year 1931 may be taken as a great divide, because the trend of growth subsequent to that year is entirely different from that in the previous decade. The period 1901-31 is characterized by a

relatively slow growth and fluctuating trend, whereas the period 1931-71 is marked by a remarkably constant increase. Furthermore, it can be observed that until 1931, Patna alone had been enjoying the rank of a city, hence any attempt to trace the changes in the cities population would mean the growth patterns of Patna only.

Period of Slow Growth (1901-31)

The city population during the first decennial census of the present century (1901-11) remained almost stagnant with a nominal increase from 1,34,785 to 1,36,135 or an increase of 1.01 per cent only. The subsequent decade (1911-21) was marked by a sharp fall of −11.88 per cent in the cities population. The reasons for this decline are the famine and spread of epidemic and endemic diseases like plague (1911), influenza (1918), malaria, etc., which took a good toll of human life resulting in a general decline of population. During this period, nearly all factors which cause a general decrease of urban population were in operation.[4] The 1901 census succeeded a period of famine which was nearly general throughout India.[5] The uncertainty of the monsoon has been characterized as "the biggest single factor influencing life of India".[6] Though a small proportion of rural population moved towards the urban centres because of the famine experienced in 1918, its growth was checked by the spread of epidemic diseases. After 1921, the condition was a bit normal and free from epidemics or famines which led to the natural process of growth from this period onward.[7] In large urban centres, municipal bodies rendered adequate service to control the natural catastrophies and gave facilities of improved drinking water and drainage and increased medical or health facilities. But the growth was still very slow as compared with the later decades. Thus, the city population rose from 1,19,976 in 1921 to 1,59,690 in 1931, an increase of 33.10 per cent.

Period of Rapid Growth (1931-71)

The city population after 1931 has been increasing at a much more rapid pace than in earlier decades and the decade 1931-41 witnessed a phenomenal rise, of 192.58 per cent. The obvious reason was the inclusion of two more new urban centres in the category of cities. They were Jamshedpur and Gaya (1941). The other causes of growth after 1931 can be attributed to industrialization and rural-urban migration. Since 1931, the growth rate as well as numerical increase of the cities has become increasingly the dominant aspect of urbanisation in India.[8] The subsequent census year further recorded a significant rise of 4,19,685 persons (89.86%) over 1941 which is more than double the percentage growth of either the State (37.07%) or India's (33.55%) urban population (1941-51). The number of cities went up from 3 in 1941 to 5 in 1951, Ranchi and Bhagalpur being

the new entrants in the city group. The partition of India and Pakistan in 1947 brought mass migration of displaced persons which had a phenomenal impact on India's urban population.[9] The migrants from Pakistan settled mostly in the urban areas because of better living facilities as well as employment opportunities.[10] In the decade 1951-61, the population of the cities was marked by a significant rise of 80.10 per cent, i.e., from 8,86,718 persons in 1951 to 13,39,910 in 1961. In addition to the substantial growth of the existing cities, emergence of two medium size towns (Darbhanga and Muzaffarpur) in the city status caused a net addition of 2,12,064 persons in 1961. With the institution of town planning schemes since 1951, especially in large urban areas, provided new impetus for the growth of cities. Apart of these, this decade was also marked by a rapid growth and expansion of industrialisation. The seed of industrialisation was sown in the yearly years of the present century, but its massive growth on various levels took place in the post-independence period. Thus, large industrial centres like Jamshedpur, Ranchi, and others drew large number of labour force resulting in sudden spurt in population growth of these cities. The increase in size of the cities like Bhagalpur, Darbhanga and Muzaffarpur was also caused by the improved means of transport and communication facilities which led to their emergence as important centres of trade and commerce. Only recently has the modern city based on industry, trade and natural resources, come into prominence.[11]

During 1961-71, the city population registered an increase of 50.45 per cent but the growth was far less than that in the previous decade. Monghyr and Biharsharif were the new cities added in the last census decade. It is evident that the city population rose from 1,34,785 in 1901 to 20,15,958 in 1971, reflecting more than 15 times increase during the seventy years. The basic reason of such a massive change in the magnitude of population was the numerical increase at a constant arithmetic rate (1, 3, 5, 7 and 9) with a common difference of two in each successive decade since 1931.

The trend of population growth in the cities of Bihar as observed above gives us a misleading picture since the analysis does not show the absolute change in the growth patterns. Moreover, to avoid the exaggerated percentage figure due to addition of new cities in every census year since 1931, Davis[12] devised two methods to measure the urban growth patterns—Instantaneous Method and Continuous Method.

The instantaneous method ascertains the population in all urban categories at each and every census, tracing the changes in each class regardless of the cities that make it up. The continuous method begins with particular cities and traces the subsequent expansion of these groups. The aforesaid description of the percentage decade variation has been calculated through instantaneous method. This method has the disadvantages

TABLE 3.3 : **Patterns of Population Growth (1931-71)**

Census Decade	Percentage variation of the cities population in Bihar		Percentage variation of Urban population in Bihar	
	Continuous method	Instantaneous method	Continuous method	Instantaneous method
1931-41	22.99	192.58	28.25	32.99
1941-51	42.46	89.86	30.75	37.07
1951-61	27.19	81.10	31.21	50.94
1961-71	35.34	50.40	23.08	43.94

Source : The calculation is based on Census of India, Bihar, General Population Table, Vol. IV, 1961 and Census of India, 1971.

of including at each census, new towns in a given class that were not in that class before.

Population growth of the cities as studied in the present analysis by continuous approach differs significantly from the growth patterns based on instantaneous approach. As for example, population growth was only 35.34 per cent during 1961-71 according to continuous method as contrasted to the growth rate of 50.40 per cent given by the instantaneous method. The Table 3.3 further reveals that the growth of population of the cities since 1931 according to continuous method has always been far below the growth rates observed through the instantaneous method. The reason is apparent because in the latter approach, the impact of movement of towns is not isolated and, thus, gives a compound rate of population growth of cities. The continuous method is, thus, the most appropriate device which may be used for measuring the absolute urban growth patterns during successive decades. It is further observed that the increase in the number of people in the cities has been sometimes, higher than the rates of urban growth in the State.

If we apply the average arithmetic method to measure the change in population of the cities on an annual basis, results obtained are more realistic than those produced by the simple compound interest formula.[18] The annual growth rates per thousand persons of the cities population during the last four decades have been computed by this method.

It will be observed that the annual rate of growth varies from decade to decade with a maximum of 95.29 per thousand person per annum in the fourth decade (1931-41) and a minimum of 33.27 per thousand persons in the last decade (1961-71). The most phenomenal rise during 1931-41 was recorded on account of the addition of two new cities, viz., Jamshedpur and Gaya in which the growth of the former was very high (164.01% per thousand). After attaining the maximum rates of growth, the city population

TABLE 3.4 : **Annual Growth Rate of the Cities Population in Bihar (1931-71)**

(*Per thousand*)

Census Decades	Observed Growth rate*	Estimated Growth rate
1931-41	95.29	95.37
1941-51	62.18	61.92
1951-61	40.93	41.18
1961-71	33.27	33.18

*The above observed growth rates have been calculated by the formula as given below.

Source : Based on Census of India., Bihar, op. cit.

successively declined and fell down to 33.27 persons per thousand per annum during 1961-71. The declining trend in the growth rate with the passage of time has been fully explained by the second degree of parabolic equation:

$$r=\frac{P_2-P_1}{P_2+P_1}\times\frac{2}{t}\times 1{,}000$$

where r= annual growth rate per 1000 persons

P_1= Population at the year of commencement

P_2= Population at the close

t= Duration of time (years)

$y= a+bx+cx^2$

where y, is the estimated growth rates

x, is the census year interval

a, is constant, b and c parameters (unknown quantities) which are to be calculated

The result after solving the equation gives

$$y= 95.3765-39.8185x+6.3625x$$

The results show that the estimated values of the growth rates (y) are very close to the observed values which are indicative of the possibility that the growth rate during the next decade and in the successive decade may go up. The observed values when plotted on the simple scale give curvilinear relationship between the annual growth rates and inter-censal decades. The city population, thus, increased from 1,59,690 in 1931 to 20,15,958 in 1971 showing a net addition of 18,56,268 persons during the last forty years.

Inter-City and Intra-City Population Growth

Growth of cities does not always occur at even pace. Instead, their trends differ largely from decade to decade being influenced by socio-economic conditions. The growth patterns of the cities in Bihar in the past periods

TABLE 3.5 : **Per cent Decade Variation of Population in the Cities of Bihar (1901-71)**

Cities	1901-11	1911-21	1921-31	1931-41	1941-51	1951-61	1961-71
Patna	1.01	—11.88	33.10	23.00	44.33	28.61	29.79
Jamshedpur	—	911.28	61.18	78.88	31.90	50.00	39.05
Ranchi	27.05	20.11	27.48	23.84	70.79	14.57	82.20
Gaya	—29.97	35.34	30.26	19.56	27.06	13.02	19.01
Bhagalpur	— 1.86	— 7.36	21.73	11.22	22.82	25.60	20.06
Darbhanga	— 5.46	—14.26	12.99	14.05	22.56	21.46	28.26
Muzaffarpur	— 4.27	—24.99	31.43	25.76	35.94	48.18	16.50
Monghyr	30.75	— 0.19	12.89	19.46	17.73	20.74	14.14
Biharsharif	—22.00	4.46	27.98	16.08	15.72	24.41	27.32

Source : Based on Census of India, Bihar, District Census Handbooks, Patna, Singhbhum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr (1961 and 1971).

have been somewhat more gentle than during modern times. In recent years, these cities are undergoing rapid change, not only in their functions as centres of industry, trade and technological innovations but also in their internal spatial structure.

The decennial variation of population in all the nine cities of Bihar since 1901 is presented in Table 3.5. It shows that in almost all census decades, the industrial city of Jamshedpur recorded phenomenal rise of population, surpassing other cities of the State. The city appeared as a township for the first time in 1911 with a population of 5,672 when the township was just being constructed (attracting a large number of both skilled and unskilled workers). The most striking feature of the 1921 census was the spectacular rise in the population of Jamshedpur to 57,360 which amounts to about 1000 per cent increase over 1911. It is significant that none of the fifteen largest cities in India showed an increase of population of more than 50 per cent. Such a steep rise of population in the case of Jamshedpur resulted from a large scale immigration in the city from the different parts of the district itself, other districts of Bihar and Orissa, other provinces of India as well as from foreign countries.

The growth of the city during 1911-21 may be judged in its right perspective by the present day standard which would bring the rate rather on a low side. For instance, the neighbouring steel plant at Rourkela which became a town after 1951 registered a population of more than 90,000 in the census 1961. Similarly, the Heavy Engineering Works at Ranchi which was also started around the same year brought 80,000 new people into the city within lese than 10 years of establishment. Therefore, the addition of 51,688 new people at Jamshedpur during the first decade of its inception is

nothing extraordinary. The growth of Jamshedpur, however, at each and every stage bears direct relation to the expansion of the parent steel works as well as the establishment of other ancillary industries.[14]

On the contrary, other cities of Bihar during 1901-21 experienced either decrease of population or a very negligible increase. Ranchi, for example, is the only city which could maintain regular rise of city dwellers, i.e. 27.05 per cent in 1901-11 and 20.11 per cent in 1911-21. The graph (Fig. 3.1 and 3.2) reveals the patterns of changes in the growth rates of population during the period 1901-71 in which the trends of growth have always been positive in the case of Ranchi and Jamshedpur. The chief reason of declining trend in other cities of Bihar during these decades can be attributed to the frequent outbreaks of epidemics. These natural calamities not only claimed lives of innumerable persons and reduced the natural increase but also adversely affected the trends of rural-urban migration.

In the subsequent decade (1921-31) the cities which could mark a moderate growth of population were Patna (33.10%), Gaya (30.26%) and Muzaffarpur (31.43%). This growth was quite natural as the amount of distress caused by natural calamities in the previous decade was minimised. The decade further saw one of the largest population influx into Jamshedpur with an addition of 72,936 persons which was primarily due to the setting up of two ancillary industries. During 1941-51, almost all cities in Bihar experienced very remarkable growth of population. Patna and Ranchi especially recorded the fastest period of their growth with 44.33 per cent and 70.79 per cent respectively. The higher rise during later decades was mainly due to setting up of the State summer capital in Ranchi, shifting of A.G. office and stationing of a contingent of troops during and after the first world war.[15] With the reduction of natural calamities and mortality rate at its lowest, the pace of industrial and commercial activities was accelerated during the post-war period. The influx of refugees from Pakistan also contributed to the increase of population in this decade. In contrast, Jamshedpur registered the slowest growth rate in its history with a mere 31.90 per cent increase.

The rate of population rise appears to have slowed down in the subsequent period (1951-61) (Fig. 3.1). The emphasis laid after independence on the uplift of rural economy, decentralisation of administrative machinery, encouragement of small scale and cottage industries, reforms in agrarian and social orders, etc., have to some extent minimised the migration of rural population to urban areas. Similar feature is more or less found in India as a whole. Jamshedpur witnessed the maximum increase of population with 50 per cent, followed by Muzaffarpur (48.18%), Patna (28.61%), Bhagalpur (25.60%), Biharsharif (24.41%), Darbhanga (21.64%) and Monghyr (20.74%). Ranchi and Gaya recorded the lowest population growth figures during this decade. The rapid growth of

Jamshedpur during 1951-61 was accounted for by the expansion of TELCO Works. This was a period of the "great leap forward" for the steel works when its production was raised from 8,00,000 tons in 1951 to 20,00,000 tons in 1958.[16] The principal causes of rise of population in Muzaffarpur were the shifting of the Bihar University headquarters from Patna, expansion and establishment of more government offices, rise in commercial activities, improvement in the field of transport and communication and also the increase in small scale industries to a fair measure. In Bhagalpur, Darbhanga, Monghyr and Biharsharif, imposition of town planning

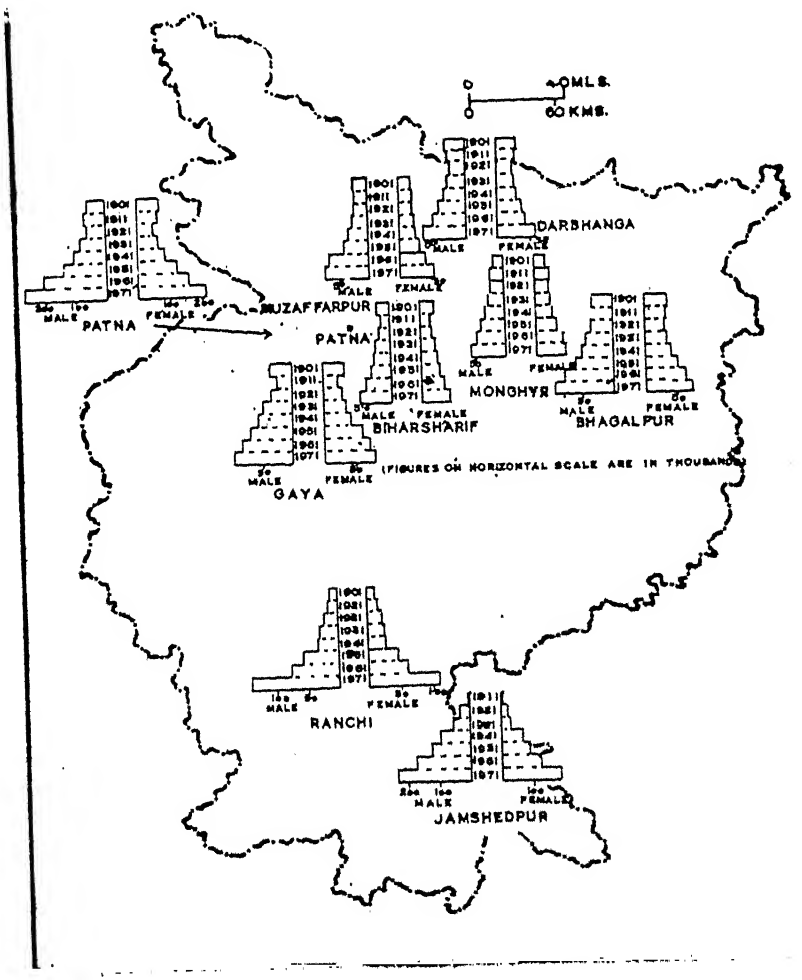

FIG 3.1 : *Decadal Variation of Population (1901-71)*

schemes, flourishing business and commercial activities and improved means of communication lines caused considerable growth of population of the cities.

In the last decade of 1961-71, the cities in Bihar experienced quite variable trends of population growth as it becomes apparent from the diagram (Fig. 3.2), based on the average arithmetic formula. Ranchi once again showed a period of maximum rise in the city population (82.20%). The most extraordinary increase in population of Ranchi was accounted for by the fact that Jagnathnagar industrial centre once forming a separate township became an integrated constituent unit to form an urban agglomeration in 1971. Muzaffarpur and Monghyr registered addition of less people as compared to the previous decade, while other cities showing relatively higher rise in population were Darbhanga (28.26%), Biharsharif (27.32%) and Gaya (19.01%).

Intra-city Population Changes

So far we have considered only the inter-city demographic trends of the cities in Bihar. In order to elucidate the intra-city population changes and its impact on population density, the study has to be limited to the census data of 1961 and 1971 for a number of reasons. In the cities of Bihar, the municipal wards have frequently been altered from time to time and in many cases these have been sub-divided and readjusted. In Jamshedpur Notified Area, for example, the census ward boundaries of 1951 had successively been altered in 1961 and 1971. In Patna, the census tracts of 1951 had been re-drawn and readjusted in 1961. Until 1961, there were 12 and 16 statistical units in Muzaffarpur and Monghyr respectively while the census data were reported on the basis of 33 units in both cases in 1971. Owing to such flexible character of statistical units on which census data are based any attempt to present realistic account of intra-urban variation of population becomes meaningless. Thus, the present analysis is restricted to the cities of Patna, Ranchi, Gaya, Bhagalpur, Darbhanga and Biharsharif, of which the municipal ward boundaries have remained undisturbed during 1961 and 1971 decades.

Analysis of data and diagram show that maximum changes in population within these cities occurred in sub urban or peripheral wards during 1961-71. In the central zone, the percentage variation of the city dwellers was extremely low and in several cases even notable decrease was observed. Being disgusted with the din and bustle of the crowded central city, people especially of the affluent society prefer to reside in the outer zone of the city. The traditional tempo of residential crowding at the city centre, or inclination to reside at place of work, is no longer a dominant factor. The new trend is for decentralisation and residential areas are being built away from the central commercial hub of the city. Thus, most of the peripheral

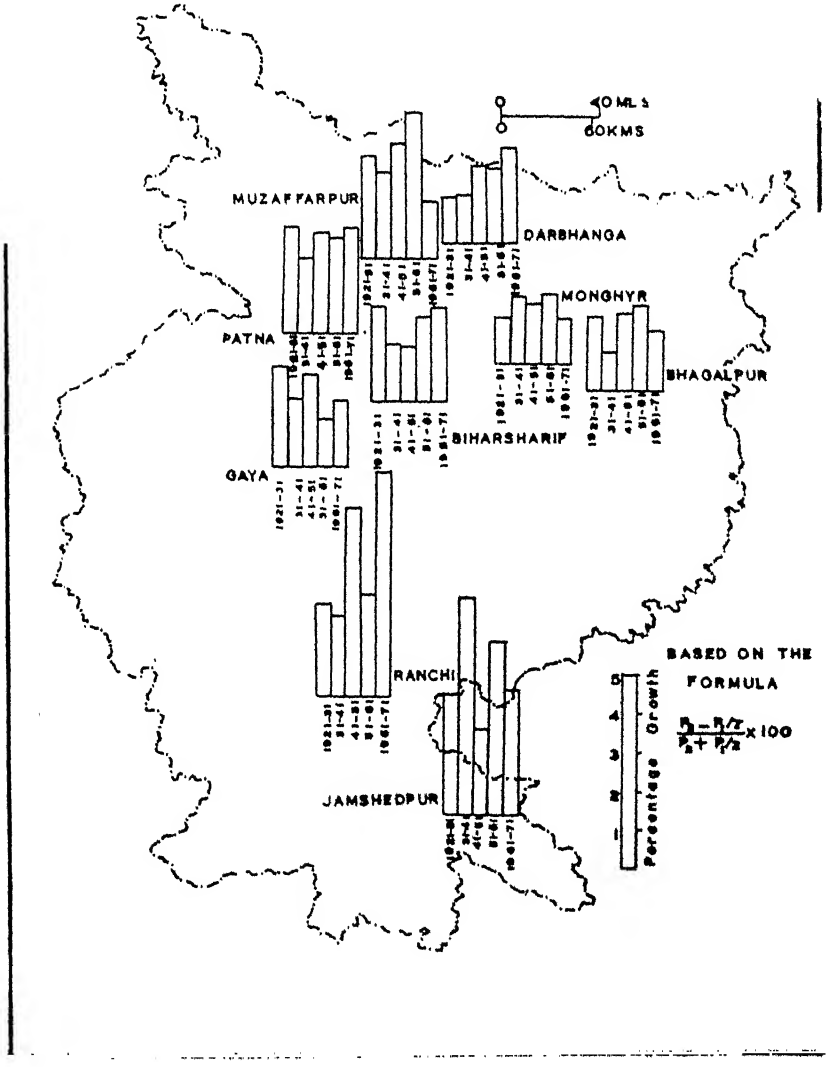

FIG. 3.2 : *Growth of Population in Cities of Bihar*

census tracts, especially to the south and south-west of central Patna recorded maximum population increase, i.e., from 40 to over 100 per cent, whereas many areas of the old Patna city were characterized by significant loss of population during 1961-71. In the transitional and outer wards, there were large variations in population changes. In Ranchi, the most spectacular rise in population took place in the sub urban areas of Jagnathnagar with 178.35 per cent growth. In addition to this, other peripheral wards of the city recorded 30 to 70 per cent increase in the decade 1961-71, while the central tracts recorded relatively low population changes, i.e., from 10 to 30 per cent because of apparent scarcity of residential houses as also due to very high centralisation of commercial functions. In Gaya, the pattern is still more distinct than in Ranchi and Patna. The most crowded central commercial tract of the city accounted for decrease of 4.75 per cent population during this decade. Areas adjacent to this Central Core (i.e., wards 2, 4, 5 and 6) registered a relatively very low amount of increase, viz., 2 to 15 per cent. The most common characteristic in almost all the cities under study is that there has been comparatively little change in the population within a radius of one mile from the city centre, followed by large change with the increase of distance out wards. In the central parts of these cities, however, as a result of very large area being put to non-residential uses and shortage of housing, there is relatively less change in population than in the outlying zones. In Patna which is characterized by bi-nodal population centre, the crowded and congested central wards in both Muradpur-Dariyapur (wards 15 and 16) and Patna city (wards 33, 34 and 35) witnessed remarkable decrease from 10 to 43 per cent during 1961-71. The population growth in the transitional and outer tracts specially to the south and south-west Patna was maximum, i.e., over 45 per cent. Study of Table 3.6 also reveals that the patterns of population changes by distance increments in other cities of Bihar were by and large similar to Patna, Ranchi and Gaya.

Applying the ecological concepts of intra-urban growth and its impact on population density patterns, the views of traditionalists and revisionists have been examined critically. The traditionalist view is exemplified by the work of Hawley[17] while the revisionist view is represented by Winsborough[18] and Schnore.[19] Both of them accepted the version that cities have cyclic growth patterns and differences in population distribution may be seen as response to the city population growth. The spectacular growth of sub urban areas and the relative decline of central population since the Second World War was studied by Guest.[20] The city according to Hawley is conditioned by the assumption of fierce economic competition for central location which is attractive to all types of activities because of its accessibility to jobs, transportation points and market. The demand for land in the centre would, therefore, exceeds the supply

which would also result in two consequences—the central residential land in particular would be sub-divided so that individual can afford rent. This would further result in a general pattern of population concentration around CBD, or to put it in another way, population density should decline with the increase in distance from the city centre. Secondly, overall density may increase due to general shortage of residential land. Subsequent population growth eventually would lead to deconcentration of population in which the city dwellers are forced outward by the complete pre-emption of the CBD. In this way, the city expands physically by peripheral growth of residential neighbourhoods. Hoover[21] has also extended his view with the notion that the city passes through sequential stages of life cycle.

The concept of revisionist ecology, on the other hand, is based on modern transportation technology which has most remarkable bearing on the distribution of population and other activities. They observed that Chicago experienced rapid population growth until 1910 by increasing its overall level of population density or congestion and then decongestion took place with later population growth. The introduction of automobile and cheap means of transportation facilities permitted movement of business, industry and other functions and thereby the growth of residential neighbourhoods at the outskirts of the city. Duncan[22] *et al.* also found that areas which were built up after 1920 had lower level of population density than areas built up before that time which is consistent with the revisionist view.

An adequate test of the ecological viewpoints would involve an analysis of the effects on density patterns of population growth during different transportation eras. Berry[23] *et al.* and Muth[24], while elucidating differences of population distribution within urban areas, were not really concerned with testing the ecological views. From the above account it would appear that both traditionalist and revisionist concepts with regard to urban population growth are really complementary to each other and the basic differences in their opinions lie in the changing time and space. The traditionalist view was found to be highly scientific and commendable until the introduction of transportation era which later brought about stupendous effect on population re-distribution and other functions (the revisionist concept).

In the light of the above ecological concept, if we examine population growth and distribution in the cities of Bihar, it stands out from the aforesaid analysis that peripheral wards have been acquiring more people than the central zone and in cities like Patna and Gaya the indigenous traditional parts have experienced notable decrease in population during the decade 1961-71. In these areas positive changes (25% to 50%) in population occurred in peripheral wards of the city where residential areas

are fast growing particularly along the principal lines of communication. The open layout, elaborate ground plan and airy structure of the houses are the order of the day for the upper class people. Almost similar patterns are found in Bhagalpur where two most congested wards (4 and 5) in and around the principal commercial area of the city witnessed extremely low amount of population increase (from 5 to 16 per cent). The maximum growth of about 20 to 45 per cent was found in the outlying wards of the city (Fig. 3.3). It has been observed that the highest population growth in Delhi Metropolitan Region occurred in transitional zones during the decade 1951-61.[55] With the imposition of town planning schemes, several planned residential areas have emerged which have been responsible for considerable amount of increase in population in the marginal areas of the city. In Darbhanga and Biharsharif, the trends of population changes are not very distinct but the general patterns are almost the same. Laheriasarai, the southern most part of Darbhanga acquired maximum percentage rise of the city dwellers (169%) during 1961-71. There is a wide variation in the growth rates in different parts of the city because of haphazard development. Thus, the urban area of Biharsharif experienced large variable trends of population increase but the overall pattern is the same. The principal commercial wards of the city recorded relatively less rise in population than the intermediate and fringing wards. At the centre, the residential areas are gradually thinning out and city dwellers are forced to shift outwards as a result of rapid growth of commercial activities.

Table 3.6 reveals some interesting features of intra-city population changes in the cities of Bihar. In the central zones, residential crowding has reached almost the saturation point and centrifugal tendency to seek residences in fringe areas has started. The traditional drive to have

TABLE 3.6 : **Percentage Variation of Population within Cities of Bihar, (1961-71)**

Cities	Distance from City Centre in Miles						
	1	2	3	4	5	6	7
Patna	45.20	55.21	57.25	45.25	37.90	41.20	45.80
Ranchi	41.30	45.10	59.25	62.70	—	—	—
Gaya	20.45	27.70	26.50	—	—	—	—
Bhagalpur	19.25	24.10	24.70	27.20	—	—	—
Darbhanga	29.85	32.40	57.97	—	—	—	—
Biharsharif	28.25	27.20	29.70	—	—	—	—

Source : Data Computation by the author.
The percentage figures are average for wards falling within respecting statistical zones.

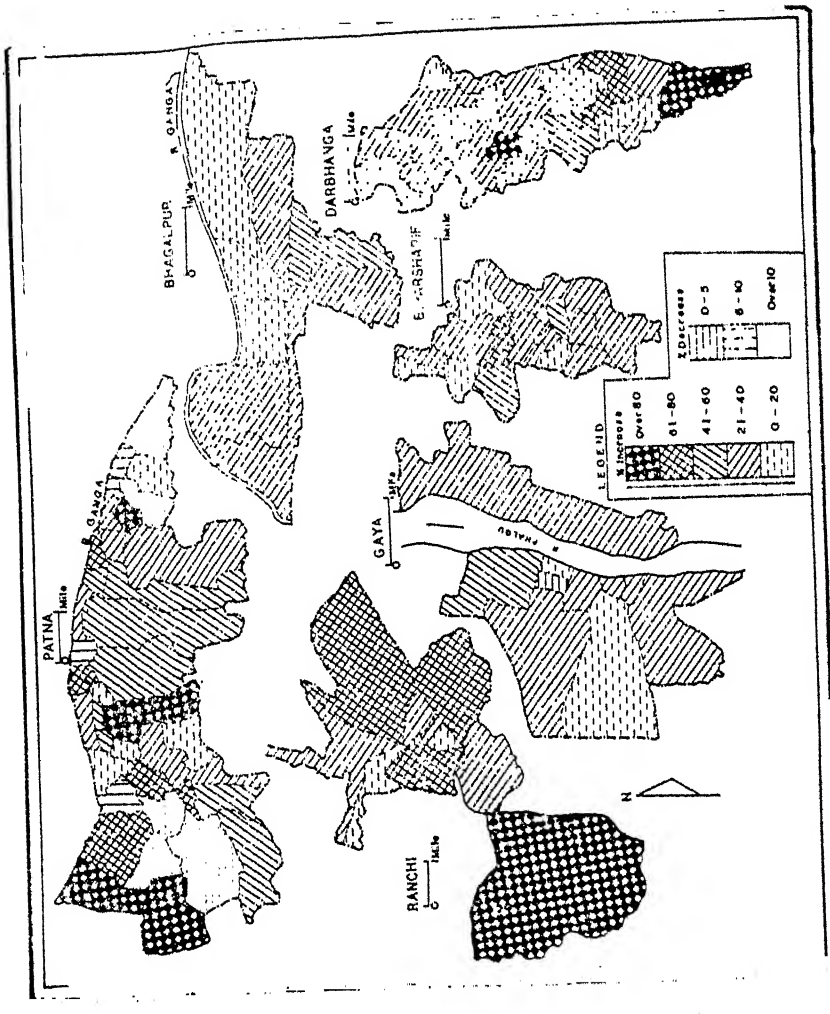

FIG 3.3 : *Intra-city Population Changes in Cities of Bihar (1961-71)*

residences in the central parts of the city is no longer a dominant pull and urban dwellers are forced to reside in transitional and outer zones. This concept is quite in conformance with the traditional ecologist. Furthermore, in large growing metropolitan cities of Patna, Jamshedpur and Ranchi, the rapid growth of residential neighbourhoods is favoured by the transportation facilities which has led to the growth of secondary commercial nodes and other functions. In modern time, the introduction of large public transport and bicycles has resulted in decentralisation of residential areas in sub urban zones of the city. With the speedy improvement in means of transportation facilities, new residential colonies and industrial units are being established along the lines of communication. The city structure under present situation can, therefore, be better explained by sector theory of urban growth advanced by Hoyt.[26]

The entire processes involved in spatial distribution of population in an urban area with the changing time and space may be put in a simple synoptic diagram (Fig. 3.4). It is evident that with the increase in city sizes, population density changes remarkably through time. The central population densities in small and medium size cities once observed to be at peak have reached at a stage where they may decline with the growth of residential neighbourhoods and cheap means of communication facilities.

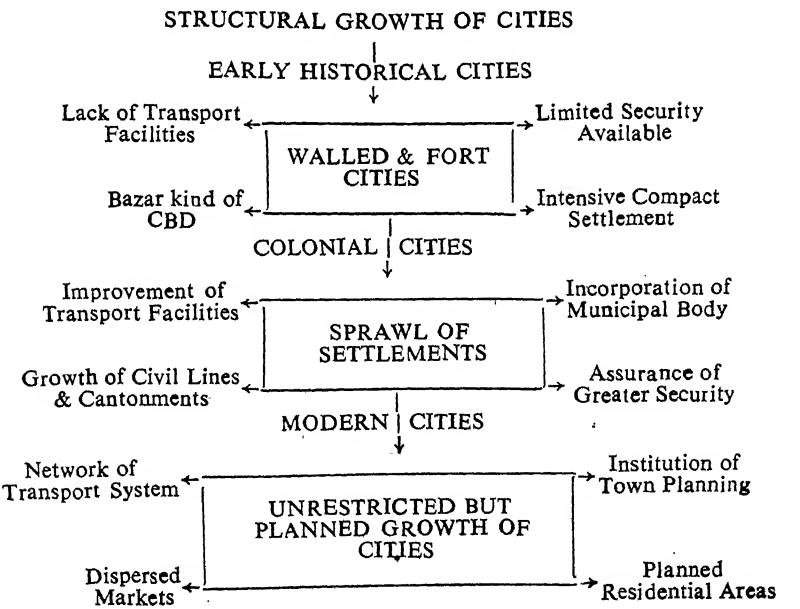

FIG. 3.4 : *Structural Growth of Cities*

Rank Size and Growth of Cities

In the aforesaid analysis of trends of population in the cities of Bihar, it has been observed that the growth rates varied widely from decade to decade depending on their potentials for growth. Further, the growth rates in the cities were not according to their size of population and some of the medium size towns surpassed the larger cities in this respect.

TABLE 3.7 : **Rank Size and Growth of Population in Cities of Bihar (1961-71)**

Cities	Rank of Cities	Actual Population Size	Growth during (1961-71)	Rank according to Growth
Patna	1	4,91,217	29.79	3
Jamshedpur	2	4,56,146	39.05	2
Ranchi	3	2,55,551	82.20	1
Gaya	4	1,79,884	19.01	7
Bhagalpur	5	1,72,202	20.06	6
Darbhanga	6	1,32,059	28.26	4
Muzaffarpur	7	1,26,379	16.50	8
Monghyr	8	1,02,474	14.14	9
Biharsharif	9	1,00,046	27.32	5

Source : Data based on Census of India, 1971, District Census Handbooks, Patna, Singhbhum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr.

The urban growth rates examined here relate to the period 1961-71. Fig. 3.5 indicates that the larger cities did not necessarily have high rates of growth. The highest rates were usually associated with the cities of sizes varying between one and five lakhs. This feature has been very much responsible for considerable variations in primacy of cities and is also one of the important reasons why the correlation between city sizes and population densities is not very significant.

Theoretically, any postulate on the relation between the size of population of a city and its growth rate is a weak one, for it is under two opposite influences. On the one hand, the large size of population of the city may be the result of its long historical existence and on the other, it may be the result of an extraordinary industrial expansion. Patna, the largest and oldest city in the State had always registered a moderate growth rate and the decade 1961-71 showed only 29.79 per cent increase. In contrast to this, Ranchi, the third largest city witnessed 82.20 per cent rise in population during this decade. Because of rapid growth of a number of industries in and around Ranchi, the city has reached its peak period of growth. The industrial city of Jamshedpur started urban career in 1911 with a population of 5,672 and within the next six decades its growth was

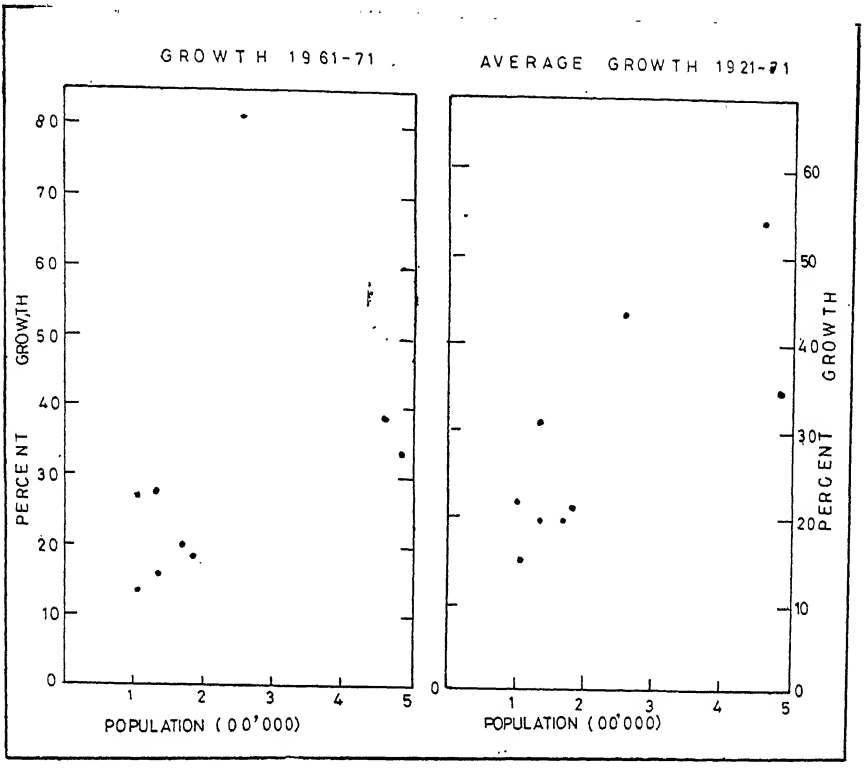

FIG. 3.5 : *Growth of Population (in relation to size of population 1961-71)*

so phenomenal that it has become the second largest city in the State. Similarly, Darbhanga and Biharsharif having sixth and ninth positions according to the actual size of population exhibit fourth and fifth positions respectively with respect to the growth rates during 1961-71. It is evident that growth of cities may not necessarily be according to their magnitude of population. Similar observations have been made by Prakasha Rao,[27] who stated that high growth and high rank of cities indicate metropolisation. But such pattern could not be observed and the medium size towns played very dominant role in the process of urbanisation in southern India.

Movement of Ranks of the Cities

Urban centres of a region are found to be well organised in hierarchical

order but their ranks because of variable growth rates change with the passage of time. Cities do not remain constant or static. Indeed, they expand in area as well as population, and in certain cases they may even decay. Some cities grow faster while some others grow with a slow pace. This, very often, results in the shifting up and down of the city status. The nine leading cities in Bihar at each census from 1901 to 1971 are shown in Table 3.8 according to their ranks.

TABLE 3.8 : **Movement in the Rank of Cities in Bihar***

Rank	1901	1911	1921	1931	1941	1951	1961	1971
1	P	P	P	P	P	P	P	P
2	B	B	G	G	J	J	J	J
3	G	D	B	J	G	G	G	R
4	D	G	J	B	B	B	R	G
5	M	Mo	D	D	D	R	B	B
6	Bi	M	Mo	Mo	R	D	M	D
7	Mo	Bi	R	R	Mo	Mo	D	Mo
8	R	R	Bi	Bi	Bi	M	Mo	Mo
9	—	J	M	M	M	Bi	Bi	Bi

*The nine leading cities of Bihar have been represented by their initial alphabets—

P=Patna
J=Jamshedpur
R=Ranchi
G=Gaya
B=Bhagalpur
D=Darbhanga
M=Muzaffarpur
Mo=Monghyr
Bi=Biharsharif

From Table 3.8, it appears that there has been a considerable shifting of ranks of the cities in Bihar. Barring Patna alone which could retain its status as the first and the largest city in the State throughout the decennial series of the Indian census, almost all other cities have changed their hierarchical positions. Until 1911, Bhagalpur, for instance, had been enjoying a position as the second largest city in the State. Thereafter, it was replaced by Gaya, Jamshedpur and Ranchi in 1921, 1933 and 1961 respectively. The steel city of Jamshedpur which emerged as an urban centre for the first time in 1911, ranking ninth among these cities, jumped

to fourth, third and second position in the successive decades 1921, 1931 and 1941. Similarly, Ranchi which ranked as the eighth largest city in 1901, changed its position several times and occupies the third position at present. Gaya, now in the fourth place, was in the second place in 1921 and 1931. Darbhanga's position remained relatively constant while Muzaffarpur fluctuated more, and Monghyr still more. Biharsharif saw a steady decline in its rank while the cities that witnessed greatest rise are Jamshedpur and Ranchi. This trend is evidently reflective of the fact that the cities having adequate growth potential went up in the hierarchical order of urban centres in the State.

Application of Rank Size Rule to the Cities of Bihar

The frequency distribution of cities according to their size and hierarchy, plotted on a double logarithmic graph paper gives a curvilinear trend which is known as the rank size rule. Several schemes related to this problem of regularity of pattern of occurrence have been proposed. This is an empirical method, first discussed by Auerbach.[28] In his subsequent work Lotka[29] found that the law of urban concentration indicated by the hundred largest cities of U.S.A., fell in the same pattern. The work of Christaller and Losch[30] were concerned with the functional rather than size categories in the theoretical model. Stewart[31] in his paper stated that the rank size is basically an empirical finding and not a theoretical proposition. The observation made by Zipf[32] has produced the rank size rule which is simplest in its forms and depicts a harmonic progression of cities within the urban hierarchy. Berry and Garrison in their paper compared the schemes of Zipf and arrived at several implications regarding the size of the city. Moreover, the region on which this rule is applied must be balanced and self-sufficient, i.e., not a part of a larger region or greatly overlapping another region. According to Hagget, this relationship may not be universally true because smaller towns are not everywhere more numerous than major urban centres.[33] The application of the rule on national, regional and local levels in various parts of the world shows that the extent of closeness of the two variables (Rank and size) is very much determined by the extent of homogeneity in the level of development. Thus, any deviation from the rule undoubtedly indicates the extent of disparity in regional development. The relationship of the two variables can be expressed by standard linear regression analysis.[34]

$$\log P_i = \log P_i - b \log R_i$$

where P_i and R_i are respectively the size (population) and rank of the i-th city; P_i is the size of the largest city and b is a constant representing the slope of the regression line. The procedure followed by Zipf is that if the

population of the largest city is known, its relationship with other cities in in a region can be established by the formula

$$P_n - P_i\,(n) - 1$$

where P_n is the population of n-th city in the series 1, 2, 3, ... n-th.

P_i is the population of the largest city.

We should, therefore, expect the fifth largest city to have a population approximately one-fifth that of the largest city, if the rank size rule were an accurate description of the relationship. According to this, all the nine cities of the State have been arrayed and ranked in descending order as per their population in 1971 and then plotted on logarithmic scale.

The relationship that has been observed in Fig. 3.6 is not linear when plotted on the logarithmic graph which means that there is a great

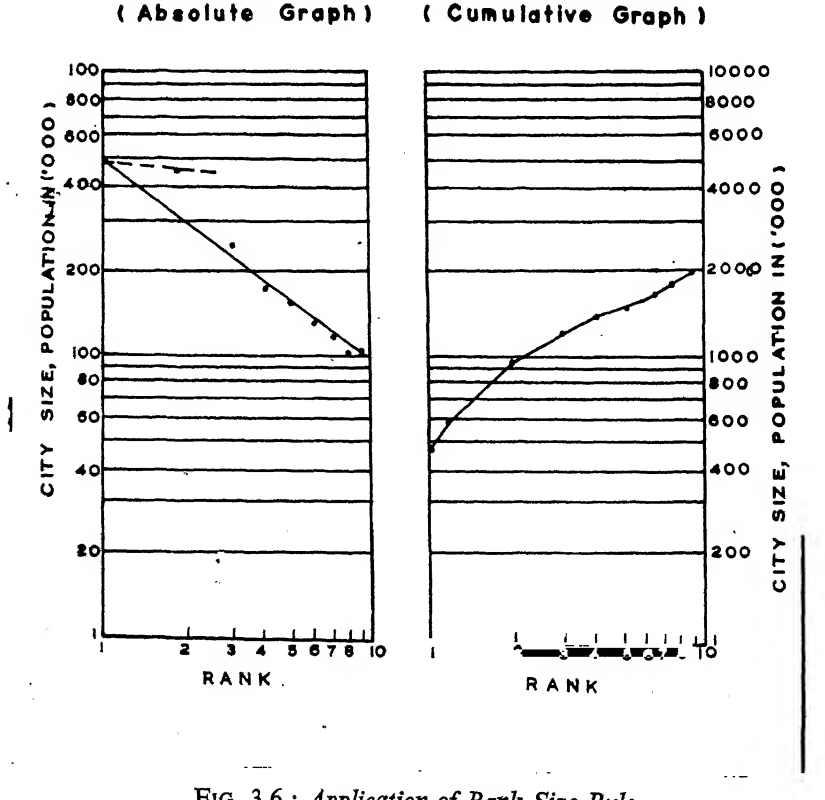

FIG. 3.6 : *Application of Rank Size Rule*

disparity in physical structure as well as levels of economic development in different parts of the State. The arrangement, however, tends to be linear when treated in two separate groups: (a) all cities above a population of 3 lakhs in which there are two out of nine cities in Bihar—Patna and Jamshedpur, (b) all other cities.

Patna has attained the present size due to its long historical existence as an imperial capital of eastern India whereas Jamshedpur has grown into a large modern city within a short span of sixty years because of extraordinary industrial expansion. If cumulative frequency data is plotted on lognormal graph, the linear expression becomes almost a straight line. Such a feature has also been observed in the case of other Indian cities.[35] Several factors such as industrialisation (mining and manufacturing), administrative character, accessibility, mode of transportation and communication development affect the rank size relationship. The phenomenal growth of urban centre in Chota Nagpur Plateau during recent decades is primarily due to the forces of industrialisation and development in the mode of transport. The Bihar Plain, on the other hand, which has been agriculturally famous since time immemorial, exhibits a lesser impact of industrialisation and the tempo of urbanisation is, therefore, most gradual.

Changes in population size and rank of a city are largely dependent upon the hierarchical arrangement of the centrality value which in turn is determined by the provision of administrative and transport facilities and the development of commerce and industry. The dissimilarity and disproportionate development of these facilities cause variation in the centripetal forces involved and, thus, affect the growth of the city. With the greater forces of attraction, the larger urban centres have developed at longer distances, while the smaller towns have relatively a close proximity to each other. The larger centres have wider spacing and are, therefore, fewer in number, while the smaller are larger in number and closely spaced.

An examination of Table 3.9 shows that the expected and actual size distribution are by no means the same. The degree of correspondence between the actual and expected distribution deviate from the rank size rule. The deviation expresses unbalanced regional development and haphazard growth of cities in the State. To bring a perfect conformation between urban hierarchy and the rank size rule, the entire region, besides being equally developed in all respects, must be uniform or what Christaller and Losch in their theoretical rationale propounded "isotropic landscape".[36] Table 3.9 further suggests that the rank size rule may be maintained if certain percentage of the city's residents move from one city to another. The deviation described above is a good overall measure for the lack of conformation of the rank size rule. Thus, we find that

TABLE 3.9 : **Application of the Rank Size Rule to the Cities of Bihar**

Cities	Rank	Reciprocal rank	Actual population size	Expected population size	Difference between actual & expected size	Difference as % of the actual population size	Difference as % expected population size
Patna	1	1.00000	4,91,217	7,12,612	2,21,395	45.07	31.06
Jamshedpur	2	0.50000	4,56,146	3,56,306	99,840	21.46	28.18
Ranchi	3	0.33333	2,55,551	2,37,537	18,014	7.05	7.62
Gaya	4	0.25000	1,79,884	1,78,153	1,731	0.96	0.97
Bhagalpur	5	0.20000	1,72,202	1,42,523	29,679	17.23	20.82
Darbhanga	6	0.16667	1,32,059	1,18,698	13,361	10.11	11.25
Muzaffarpur	7	0.14286	1,26,279	1,01,802	24,575	19.44	24.14
Monghyr	8	0.12500	1,02,474	89,077	13,397	13.07	15.04
Biharsharif	9	0.11111	1,00,046	79,179	20,867	20.85	26.35
X		2.82897	20,15,958	20,15,887	4,42,861	155.24	165.43
X/N		2.23995	2,23,985	2,23,987	—	17.25	18.38

Source : Computation work by the author (Based on the Census, 1971).

the greater the percentage of deviation the less the conformity. The larger cities reflect greater amount of discrepancy because of their disproportionate size. Patna, for example, accounts for about half of the total amount of deviation for all cities in Bihar. The figures in the last two columns represent the average discrepancies between the actual and the expected size of population in each city as per cent. The number in each case shows the per cent figure by which the population of the city would have to increase or decrease to bring about a correspondence between the actual and expected size. Each of the above measure indicates that the hierarchy of the cities of Bihar deviates considerably from that anticipated on the basis of the rank size rule. The maximum discrepancy has been observed in the case of Patna (45.07%) and Jamshedpur (21.46%), followed by Biharsharif (20.85%), the former two being the first and second largest and the latter the smallest city in the State. This shows that certain patterns of deviation may be discerned. The measures shown in Table 3.10 indicate not only the amount of deviation from the rank size rule but also the pattern of deviation among the individual cities. The possible patterns with regard to the size of cities are as follows:

(a) The larger the city the greater the discrepancy between the actual and expected size.
(b) The smaller the city the greater the discrepancy between the actual and expected size.

TABLE 3.10 : **Measures of the Actual and Expected Size of Cities, based on Rank Size Rule**

Cities	Expected minus actual size as % of the actual size	Rank ignoring sign	Rank considering sign	Expected minus actual size as % of the expected size	Rank ignoring sign	Rank considering sign	Rank of actual population size
Patna	+45.07	1	1	+31.06	1	1	1
Jamshedpur	−21.46	2	9	−28.18	2	9	2
Ranchi	− 7.05	8	3	− 7.62	8	3	3
Gaya	− 0.96	9	2	− 0.97	9	2	4
Bhagalpur	−17.23	5	6	−20.82	5	6	5
Darbhanga	−10.11	7	4	−11.25	7	4	6
Muzaffarpur	−19.44	4	7	−24.14	4	7	7
Monghyr	−13.07	6	5	−15.04	6	5	8
Biharsharif	−20.85	3	8	−26.35	3	8	9
Rank Co-efficient of correlation		+0.16	+0.43		+0.16	+0.43	

Source : Computation by the author, based on Census of India, 1971, *Ibid.*

(c) The larger the city the more its expected size exceeds its actual size.

(d) The smaller the city the more its actual size exceeds its expected size.

So far as no discernible connection had been established between the size of a city and the direction of its deviation from the rank size rule. The rank order coefficient of correlation calculated above (Table 3.10) provides much standardised measure of certain rule. If the pattern 'A' holds in the State, we should find that the ranks in the column 3 agree closely with the ranks of population size in column 8. The positive coefficient of 0.43 shows that the relationship between the actual and expected size of the cities in Bihar is significant. It also reveals that the pattern 'B' is more predominant than 'A', i.e., the smaller the city, the greater is the discrepancy between the actual and expected size. Pattern 'A' is found to a large extent in the case of Patna and Jamshedpur only. As the size increases, the amount of deviation from the rank size rule is likely to be enhanced. The positive coefficient figure of 0.16 in columns 4 and 7 indicate the presence of 'C' and 'D' patterns in the cities of Bihar. It further indicates that the size varies directly with the amount by which the expected size exceeds the actual size. Thus, the pattern 'C' prevails

in Patna and that of 'D' in Jamshedpur, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur, Monghyr and Biharsharif.

If we consider the city size hierarchy with regard to stability, any change in the present rank size relationship would be mainly due to two important reasons, (i) the movement of medium size towns into category of cities, and (ii) sudden upsurge in the present growth rate of the individual cities. If the growth rates for all cities during a period are the same, there is no change in their rank within the hierarchy.

Future Estimate of the Cities Population

Although the State of Bihar has traditionally been rural, there are undeniable evidences that a change is taking place. The acceleration in the growth of a number of cities, the correlation between size of city and rapid growth, the trends towards industrial and commercial expansion, the increasing rate of female employment—all indicate that urbanisation in Bihar as in India is most likely to gain momentum as it advances. Barring some major catastrophies, the pace of population growth in the cities of Bihar may become extremely rapid.

Furthermore, the growth of the cities population over the last several decades has been conditioned by many complex social, political, physical and economic factors. In the changing state of national economy, these factors are likely to play increasingly dominant role in the future population pattern of the cities. Industrialisation in Bihar, which was initially more or less confined to the minerally rich belts of Chota Nagpur, has now spread to many new areas. Thus, the changing performance of the economy would accelerate the tempo of urbanisation.

Population projections are made on certain assumptions of the controlling factors. A normal population estimate assumes that the factors affecting birth, death and migration will interact in a normal manner, i.e., the economic and social progress of the country will take place as set forth in the government's overall development and will not be dislocated by external wars or internal strifes of natural calamities. The conventional approach of accepting the minimum growth on the basis of current trends might lead to projection far short of the inevitable, expecting that no such extraneous factors will hamper the growth of population in a few decades to come and that the population of the cities will grow in a normal condition. Thus, the basic assumptions behind the estimate of population are as follows:

1. The cities of Bihar have been growing at differential rates based on the regional socio-economic background. This character of the cities is likely to continue in future.

2. The growth of the cities of Chota Nagpur would be mainly influenced by the degree of industrialisation.
3. The cities in Bihar Plain are largely devoid of large scale industrial location within or at the fringe of the cities. The population growth would, therefore, be determined by the rapid increase in commercial activities, expansion of administrative functions and higher education.
4. The cities will continue to function as seats of administration and centres of higher learning and would, therefore, maintain their present character.
5. The bulk of changes in the total population of cities would largely be due to emergence of medium size towns into the category of cities.

There are several statistical methods to estimate the future trends of population but these techniques are apt to give widely varying results as there is no fixed law of population increments. The statisticians are further handicapped by the fact that neither birth and death rates are properly registered in India nor migration (particularly in and out migration) figure and economic and social indices available. To arrive at a conclusion with reasonable accuracy, the common and simple methods employed here are the least square method, arithmetic and geometric progression. While applying these techniques, it has been considered desirable to take the census year 1921 as the base, as the data for earlier decades show wide fluctuating trends of growth and are likely to vitiate the result if taken into account.

The above estimates of population of the cities in Bihar through different methods furnish widely varying results (Fig. 3.7). The estimates

TABLE 3.11 : **Future Population Projection in the Cities of Bihar**

(in lakh persons)

Census Year	Actual population	Estimated Population*		
		Least square method	Arithmetic method	Geometric progression
1921	1.19	—	—	—
1971	20.15	—	—	—
1981	—	27.13	23.95	35.36
1991	—	36.87	27.52	44.65
2001	—	42.27	31.28	76.84

Source : Data computation by the author.

*Detail procedure for analysis of the above methods of population estimate is attached in the appendix.

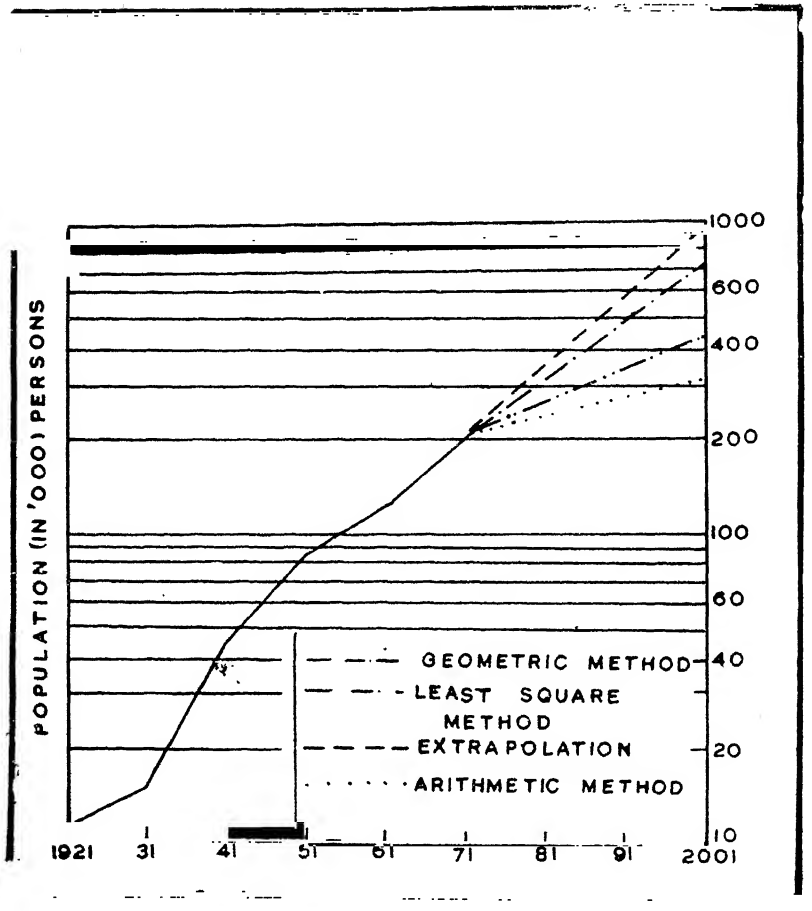

FIG. 3.7 : *Projection of Population in Cities of Bihar*

based on geometric progression are highly exaggerated while the arithmetic progression gives too low a figure. The least square technique, on the other hand, provides median values which seem to be more realistic than other methods. The simple method of extrapolation is concerned with the fitting of a straight line, non-linear or logistic curve to the census figures available.[37] Admittedly, this method is crude and there is no necessary relation between the goodness of fit of a curve to past observations and its reliability for forecasting purposes.

It is now certain that population in the cities of Bihar will increase at much more rapid rate than already observed during the past decades. It has also been found that the area of a city does not expand in direct

proportion to the growth of population which results in increased pressure of population on the limited urban space. The rural urban migration will be the most important reason in swelling up population in the cities. Larger cities because of better living condition as well as opportunity for employment would draw relatively more people than the smaller ones. Migration has been taking place particularly since 1941 in uncontrolled and unregulated way from rural areas and this has resulted in an imbalance in urban amenities.[38] The above estimates may also be confirmed by the remark of Sachin Choudhari who states that "India is passing through the intermediate stage of fast growth. Population pressure and stagnation of the rural economy have made rapid urbanisation proceed rather than follow industrialisation. It is likely that urbanisation will be even faster until it levels off after, say, 40 per cent of the total population".[39] In addition to this, the population of cities will largely be enhanced by their numerical increase. As it is apparent from the growth of the cities that after 1931, cities in Bihar have been appearing in each successive decade in arithmetic progression with a common difference of two. If the present trend continues, two more cities are likely to come up by 1981—the new prosperous steel city of Bokaro and Arrah already have a population of more than 90,000 (1971).

REFERENCES

1. Growth of the World's Urban and Rural Population (1920-2000), United Nations, New York, Department of Economics and Social Affairs, Population Studies, No. 44, 1961, p. 1.
2. According to Census reports, Urban Centres having 100,000 persons or more are defined as cities (Class I towns).
3. Brush, J.E., Spatial Patterns of Population in Indian Cities, Geographical Review, Vol. 58, 1968, p. 362.
4. Davis, K., The Population of India and Pakistan, Princeton University Press, New York, 1951, p. 43.
5. Census of India, Age, Table and Rates of Mortality, 1901.
6. Stamp, L.D., Asia: An Economic and Regional Geography, Dutton, New York, 1938, p. 199.
7. Census of India, Report, Vol. I, 1911, 1921 and 1931.
8. Pal, S.K., Changing Role of Urbanisation of Central Cities in India, Geog. Rev. of India, Vol. XXXII, No. 2, 1970, p. 97.
9. Davis, K., op. cit., p. 121.
10. Bogue, D.J., Urbanisation and Migration in India (Ed. by Roy and Turner), India's Urban Future, Asia Pub. House, Bombay, 1962, p. 31.
11. Davis, K., op. cit., p. 127.

12. Davis, K., op. cit., p. 128.
13. Gibbs, P.J., Urban Research Method: D. Van Nostrand Comp. INC, New York, 1966, p. 107.
14. Dutt, A.K., Jamshedpur and its Umland: A Study in Urban Geography, (unpublished), Ph D. thesis, 1959, pp. 125 27.
15. Draft Master Plan, Ranchi, Department of Town Planning, Bihar, 1965, p. 18.
16. Draft Master Plan, Adityapur-Jamshedpur, Department of Town and Country Planning, Bihar, Patna, 1962, p. 126.
17. Hawley, H.A., Human Ecology: A Theory of Community Structure, Ronald Press, New York, 1950.
18. Winsbarough, H.H., City Growth and City Structure, Journal of Regional Science, Vol. 4, 1962, pp. 35-49.
19. Schnore, Leo, 'Metropolitan Growth and Decentralisation'; The Sub-urban Community (Ed. William, M.D), Putnaw, New York, 1958, pp. 3-20.
20. Guest, M.A , Urban Growth and Population Densities, Demography, Vol. 10, 1973, pp. 53-68.
21. Hoover, E.M. and Ramond, V., 'Anatomy of a Metropolis: The Changing Distribution of People and Jobs within the New York Metropolitan Region, Double Day & Co., Garden City, 1962.
22. Duncan *et al.*, Pattern of City Growth, American Journal of Sociology, Vol. 67, pp. 418-29.
23. Berry, op. cit., pp. 389-405.
24. Muth, F., Richard, Cities and Housing: The Spatial Pattern of Urban Residential Land Use, Chicago University Press, Chicago, 1969.
25. Nagina, S., Delhi Metropolitan Region: A Study in Settlement Geography, K B. Publication, New Delhi, 1976, p. 46.
26. Hoyt, H., The Structure and Growth of Residential Neighbourhoods: In American Cities, Federal Housing Administration, Washington, 1939.
27. V.L.S. Prakasha Rao, 'Some Aspects of Urbanisation in Southern India', Census of India Publication, 1961, pp. 3-4.
28. Auerbach, F. Das, Gestz der Bevolkungs Konzedtration Petermann's Geographic Che Mittilungen, Vol. 59, Part I, pp. 74-76.
29. Quoted by Clarke, J.I., Population Geography, Pergamon Press, Oxford, 1966, p. 52.
30. Referred by Hagget, P., Locational Analysis in Human Geography, Edward Arnold, London, 1970, p. 101.
31. Stewart, J. and Charles, T., ibid.
32. Browing, L.H. and Gibbs, P. Jack, System of Cities: Some measures of Demographic and Spatial Relationships Among Cities in 'Urban Research Method' (Ed. by J.P. Gibbs), D. Van Nostrand Comp, New York, 1966, p. 441.
33. Hagget, P., ibid.
34. Marshall, J.V., The Location of Service Towns: An Approach to the Analysis of Central Place System, University of Toronto Press, Toronto, 1971, p. 49.
35. Ahmed, K., Indian Cities: Characteristics and Correlates, Paper No. 102, Department of Geography, University of Chicago, Illinois, 1965.
36. Toyne, Peter and Newby, T. Peter, Techniques in Human Geography, Macmillan Education Ltd., 1971, p. 179.

37. Isard, W., Methods of Regional Analysis: An Introduction to Regional Science, New York, 1960, Chapter 2.
38. Kuppaswamy, B., Social Change in India, Vikas Publishing House, Bombay, 1972, p. 340.
39. Choudhari, S., Centralisation and the Alternative Form of Decentralisation: A Key Issue; India's Urban Future, op. cit., p. 218.

4

POPULATION DENSITY PATTERNS IN THE CITIES OF BIHAR

THE SPATIAL variation of population within urban areas does not occur at random, instead, like other social laws, it tends to follow a definite empirical regularity. Every city tends to conform to a common pattern of internal population distribution, although a variety of local disturbing factors may, in individual city obscure or severely modify it.[1] Not a single city has so far been observed which is so free from these as to exhibit exactly the standard pattern. It has been attempted here to analyse the internal distribution of population in the cities of Bihar in the light of the existing negative exponential model initiated by Bleicher (1892) and later elaborated by the economist Colin Clark (1951). The basic assumption of the concept is that regardless of time or place, the urban population densities decline in a negative exponential manner, e.g., decrease of densities with the increase of distance from the city centre. Later Clark and a number of scientists in support of this concept, compiled a large number of evidences from different parts of the world in which the relationship was found to be a good fit. Besides, they also found that the patterns hold good not only for western cities but also for non-western cities. A critical appreciation of some important contribution is essential before analysis of the present problem is, indeed, taken up.

Clark Density-Distance Model

The fundamental law of decline of population density with the increase of distance from the centre of urban areas was discovered first by Bleicher in 1892 but like Mendal's law, it was not taken up and had to wait for rediscovery by Clark in 1951.[2] Clark's derivation of the distance decay function model gave a satisfactory explanation for not only population density variations within urban areas but also for several socio-economic attributes of the community. He produced evidences in support of his

argument that regardless of time or place, the spatial distribution of population densities within cities appears to conform to a single empirically desired expression

$$dx = do^{e-bx}$$

where dx is population density d at distance x from the city centre, do is the central density as extrapolated, and b is the density gradient, indicating the rate of diminution of density with distance (a negative exponential decline, Fig. 4.1).

This is supposed to be an important landmark in the field of urban geography and other social sciences. In Chicago, Winsborough[3] found the

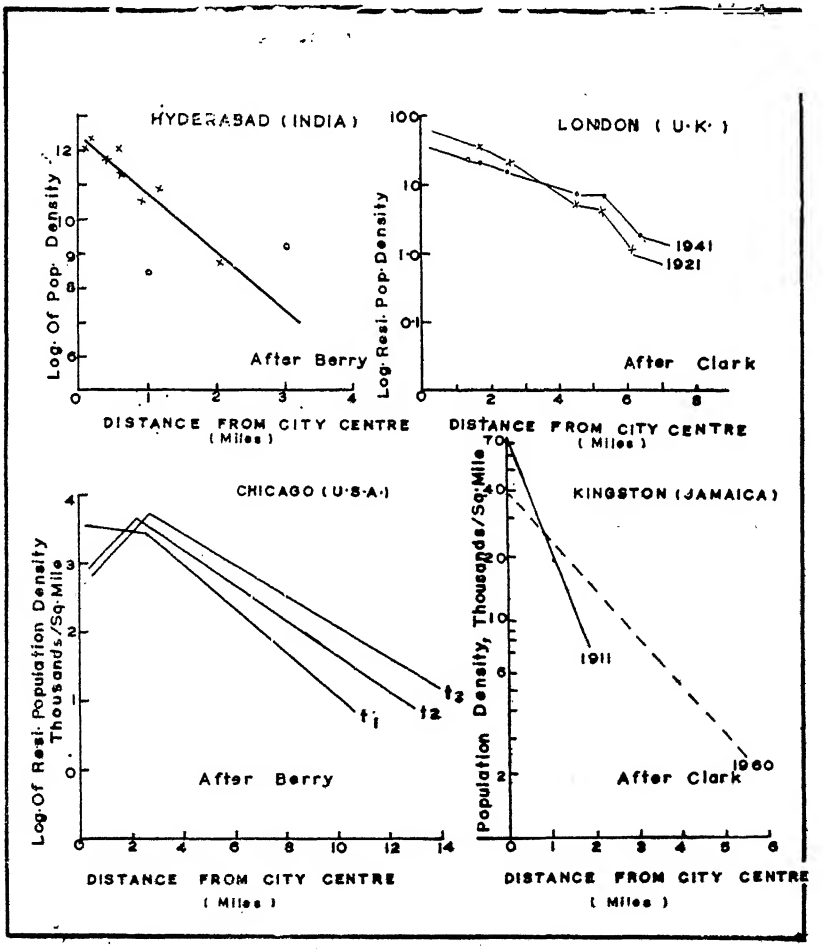

FIG. 4.1 : *Population Density Patterns*

pattern to hold for every census year from 1860 to 1950. Muth and Weiss[4] found that the patterns are quite favourable for all large U.S.A. cities studied in 1950. In Asian countries also, observations have proved Clark's negative exponential decline patterns to be good fit. Kar's[5] study of Calcutta has shown that negative decline of density existed in 1881, 1901, 1921 and 1951, Tanner and Sharratt[6] for the first time intending to modify the model, suggested that urban population densities decline exponentially as square of distance. The density profile observed, is thus, a half bell curve. Their formulation is, however, still inadequate as a general rule and does not find much support at the intra-urban scale. Newling provided an alternative hypothesis of spatial variation of urban population densities which like Sharratt also follows quadratic exponential decline of densities. He stated that large cities having very extensive Central Business District with largely non-residential uses of land will have in the density profile a central density crater with a crest bordering the CBD. Beyond this crest, the curve falls away to the suburb. In a later study, Clark also discussed the worldwide phenomenon of outward movement of population from cities to suburb and presented evidence that the density gradient in Poona declined between 1881 and 1953 which he interpreted to mean that dispersion had occurred.[7]

Revision of Clark's Model by Berry, Simmon and Tennant

After twelve years of Clark's formulation of the negative exponential law, Berry and his colleagues[8] contributed an important paper relating to urban population densities. The primary objective of the paper was to review and elaborate Clark's work especially in the light of the recent related contributions of Muth, Weiss, Stewart, Alonso, Winsborough, Beckman and others. Berry and his associates also found the rule to hold a good fit for all time and all places, but one thing that Clark had not done, was to provide a theoretical base for his formula. His observations of thirty-six cases hardly enable one to assert complete universality of the law. In addition to their own observation of about hundred examples from different parts of the world, they also examined the works of a number of social scientists and found that no evidence had so far been discovered to counter Clark's assertion of the universal applicability of the equation.

To provide a sound theoretical base Berry *et al.*,[9] selected several variables, i.e., land use patterns, land value, per unit residential households, front foot value of residential land, etc., which directly or indirectly influenced the density gradient patterns. The intensity of all these parameters diminishes sharply outward with the increase of distance from the city centre. From these and many others, it appears that a negative exponential decline of densities must hold and the equation of Clark is a logical outcome of urban land use theory. The most remarkable feature of their finding is that they developed numerous equations for different sets of

cities, as for instance, the equation (8) illustrates that as the population of a city increases, the density gradient diminishes or that smaller cities are more compact than larger cities by virtue of their steeper density gradients. Finally, they observed that the density gradient changes with the change in city size and also presented sharp contrasting patterns between western and non-western cities. "As western cities grow through time, they experience steady decrease in density gradients and, therefore, in degree of compactness, where central densities first increase and later decrease, to the contrary, in non-western cities, central density increased steadily but the urbanised area relatively did expand little and hence, density gradient remained constant"[10] (Fig. 4.2). This leads us to postulate that density

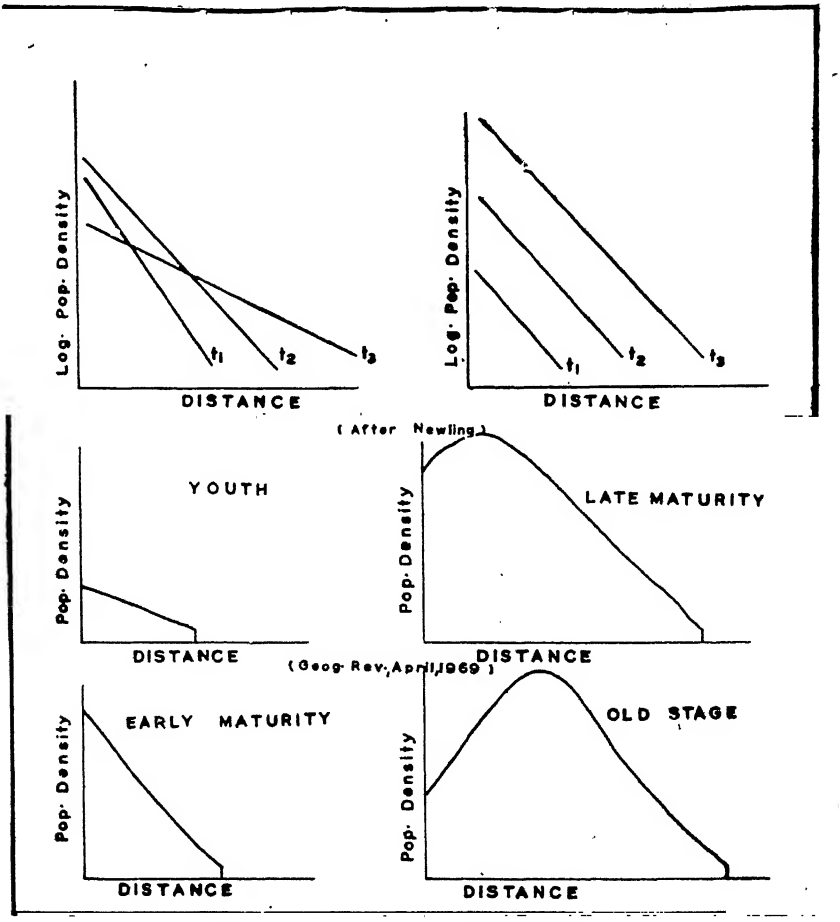

FIG. 4.2 : *Urban Population Density Models (after Berry, Simmon and Tennant)*

gradient is a function of the size of a city, shape distortion and proportion of manufacturing outside the central city. In short, it may be noted that at any point in time the empirical regularity to be observed is the same, but through time the patterns differ.

Brush's Investigation of Indian Cities

With regard to distributional patterns of population in cities, Brush after his countrywide personal investigation of some major Indian cities, contributed a most interesting paper in 1968[11] which he further elaborated in 1972.[12] The principal objectivess of the paper was to analyse the intra-urban spatial patterns of population and its change through time. Interpreting the density distance relationship, Brush found that Indian cities must take account of the existing models of urban structure, i.e., a downward gradient from the greatest concentration in the centre towards the periphery. The model observed is in conformance with the negative exponential rule proposed by Bleicher and Clark, and later justified by Berry, Simmon and Tennant.

Although the density-distance relationships have statistical significance and generally conform to the existing model, Brush remarked, "Indian cities because of complexity in internal structure (social, economic and cultural) show certain departure from the basic norm". The first and the most common pattern occurs in cities where the highest density of population is found in a compact central area situated in or adjacent to an indigenous *bazar*. Within one or two miles from the centre, the gradient slopes sharply downward to the periphery. Another set of patterns resembling that of western cities has been observed in British built port cities where the CBD is principally occupied by offices, banks, commercial activities, etc., and where the density gradient is relatively low. Within a mile and a half it may reach an extremely high level and beyond that it declines gradually. A third configuration is found in cities having two distinct nodes of population concentration—one around the old traditional and indigenous *bazar* and the other around the former British developed centre which may be a little distance away. The fourth pattern is found in the western planned cities which are characterized by low population density all over the town in general and in the central area in particular (Fig. 4.3).

While making a critical analysis of Brush's derivation of density-distance model it appeared that he has given due importance to the history of origin and process of growth of cities which are supposed to be the most fundamental controlling factors of the central density and density gradients within cities. He distinctly classified Indian cities into four different groups based on the history of origin such as pre-British, British, planned and cities developed under western influence. His findings are the direct outcome of ecological processes of growth operating through time and are, therefore,

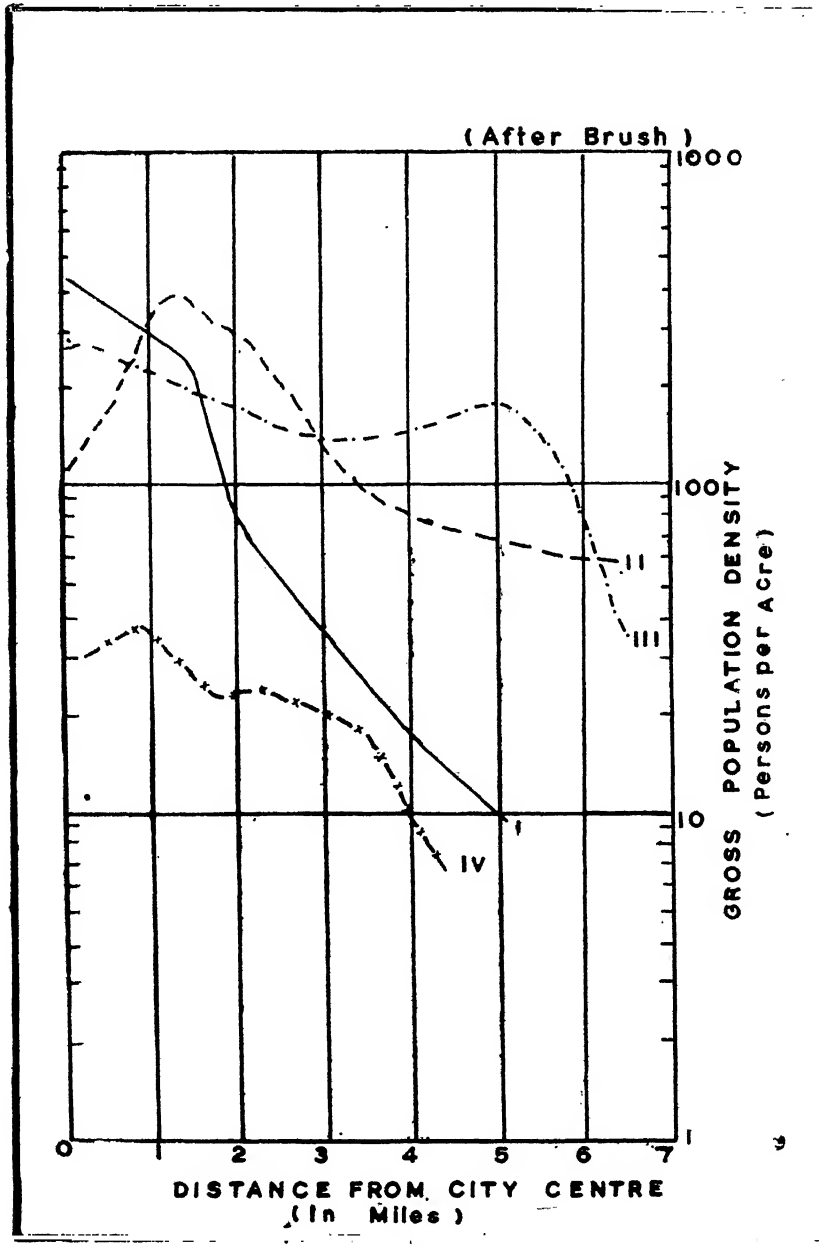

FIG. 4.3 : *Population Density Profiles (Cities in Groups I, II, III and IV)*

scientific and realistic. But it would be unwise to presume that the above four models observed can explain population density gradient patterns for all categories of cities in India. Administration, as a matter of fact, is the backbone of Indian urbanisation and administrative set-up has been innovating as an important nucleus of urban growth around which large suburban sprawls have taken place. Most of the large cities in India are of predominantly administrative functional character which has considerable impact on flattening of density gradient beyond the central city. Similarly, there are transport cities where transport like railway forms the nucleus of urban growth and where settlements have grown around it, the density curve shows an entirely different pattern from that observed by Brush. In modern times, many cities are expanding in size as a result of large industrial establishments at the margin of the city and as such these have essentially influenced the patterns of population density. The observations of Brush are, therefore, not sufficient for detailed intra-urban spatial variations of population in India, because the circumstances in which urban centres in India grew are not easy to explain. To be precise, the Indian cities because of a number of social, economic and cultural contrasts have very complex internal spatial structure.

Present Method of Analysis

For measuring the extent of spatial variation of population within cities, the basic ward-wise data have been procured from the District Census Handbooks, 1971. With the help of existing land use maps of the cities under study, dots for population distribution in each census ward were placed on the built-up area and concentric circles half a mile apart were drawn from the city centre. As far as the reconnaissance of the city centre is concerned, there is a practical difficulty in selecting it (especially in linear type cities) because of complexity in internal structure of most Indian cities. There is, however, one nodal point in the principal commercial belt of the city where almost all major roads and streets intersect or converge and where maximum traffic flow is observed during business hours. Land values are also supposed to be the highest around it. This has been primarily identified by frequent field observations and in the case of complexity the city centre has been chosen through direct interrogation with government officials and some responsible persons.

Later, dots in each circle were counted in order to show the magnitude of population and areas falling under them was measured. Straight line measurement of distances has been taken as the basis of calculation from the centre to certain other parts of the city. Results are presented from the analysis of the Census (1971) data for gross population density and for net residential density only for two of the nine cities, namely, Gaya and Darbhanga for which residential data were approximately calculated.

As soon as the density of population and measurement of distance from the central commercial nodes have been assembled, the data have been treated in terms of linear regression computed by the least square method according to the formula.

$$y=a+bx$$

where y is the population density expressed as log of persons per acre and is treated as dependent variable. The independent variable x is the distance expressed in miles, where a is a constant and b a parameter (variable), both of which are derived from density data on given formula.

Later, scatter diagrams have been drawn with the independent variable on the horizontal 'x' axis and dependent variables on vertical or 'y' axis. The diagrams clearly show the causal relationships between two variables which is apparently linear in character. The regression of 'y' on 'x', has, therefore, been determined by drawing a straight line through least square method which is more accurate and scientific[13] than if a mere descriptive or estimated analysis were attempted. For a linear statistical association among the variables, Pearsonian Product Moment of correlation is commonly used to show the degree of relationship. The following formulas have been applied for various statistical analysis.

$$r=\frac{\Sigma xy-\frac{\Sigma x\,\Sigma y}{N}}{\sqrt{\left\{\Sigma x^2-\frac{(\Sigma x)^2}{N}\right\}\left\{\Sigma y^2-\frac{(\Sigma y)^2}{N}\right\}}}$$

where r=Pearsonian Correlation of Coefficient
x=sum of all x values
y=sum of all y values
xy=sum of products of all x and y values
N=Total number of observations.

The regression coefficient has been tested for accuracy of estimate by calculating the standard error of estimate because for large samples, as here, it is a measure of the error to be expected in estimating y from a given value of x by means of computed values of y. The standard error of estimate is the standard deviation of y multiplied by square root of $1-r^2$ so that

$$Sy^2x=\sigma y^2\,(1-r^2)$$

$$\text{Therefore } Syx=\sqrt{\frac{1}{N-1}\left[\Sigma y^2-\frac{(\Sigma y)^2}{N}\right]}\times\sqrt{1-r^2}$$

where Syx=Standard error of estimate
r=Coefficient of correlation

Other values are the same as above. The standard error of estimate gives the probability of error for two-thirds of all cases on either side of the regression line. The lines for standard error of estimate have been drawn on all the scatter diagrams and the term has been included in the final equation calculated as

$$y=a+bx\pm Sey.$$

Furthermore, coefficient of determination has been calculated to measure the percentage of the variation in one variable which is explained by variations in the other. For this reason in cases where the dependent variable is known to be casually related to the independent variable (r^2), may be called the coefficient of determination. Thus, it can be used to determine the percentage to which the variance of 'y' is influenced by 'x' since it measures that proportion of all the elements of variance in 'y' which are also present in '*x*'. The coefficient of determination is, thus, derived by the formula

$$dxy=R\,ry^2\times 100 \text{ (per cent)}$$

Finally, *F*-ratio has been calculated to show the level of significance of correlation on one per cent or five per cent level to determine whether the chances of obtaining the calculated relationships are significant or not.

Negative Exponential Decline of Population Density Observed

From the analysis of data it appears that the density distance relationships have statistical significance and the overall pattern observed is in conformance with Clark's model based on negative exponential decline of density with the increase of distance from the city centre. The spatial distribution of population in the cities of Bihar tends to conform to a common pattern although a variety of local disturbing factors have in individual city modified the regularity. It is also noteworthy that in many cases the patterns are most likely to support Brush's observations. The basic features about population distribution stand out clearly from the data mentioned in the Table 4.1.

It has been found that extremely high population densities exist around the old indigenous *bazar* where it may be as high as 250 persons per acre. The density declines sharply downwards to the periphery to as low as below 10 persons per acre. The pre-British cities like Gaya, Muzaffarpur, Darbhanga and Monghyr exemplify this type of density gradient patterns.

In spite of their long existence since historical and pre-historical time, these cities could develop only in small areas with a single pronounced central density. A different pattern of density distance gradient is observed in the case of Patna and Bhagalpur where because of the principal seats of British administration, the old traditional *bazar* could no longer remain

TABLE 4.1 : **Zonal Distribution of Population in Cities of Bihar, 1971**

City	Distance from city centre (in miles)	Area in acres	Population 1971	Percentage of total area	Percentage of total population
1	2	3	4	5	6
Patna	0-1	1395.90	1,03,800	7.64	21.10
	1-2	3230.40	96,200	17.67	19.55
	2-3	4062.40	95,800	22.23	19.47
	3-4	4194.20	73,000	22.94	14.84
	4-5	2642.20	70,000	15.55	14.23
	5-6	1583.20	37,400	8.66	7.60
	6-7	874.20	14,600	4.76	2.98
	7-8	97.00	1,100	0.53	0.23
Total		18279.50	4,91,900	100.00	100.00
Jamshedpur	0-1	1919.90	70,400	6.67	15.41
	1-2	5694.40	1,33,200	19.79	29.16
	2-3	9095.40	1,72,000	31.62	37.95
	3-4	8428.40	78,000	29.30	17.08
	4-5	3631.60	3,200	12.62	0.70
Total		28769.70	4,56,800	100.00	100.00
Ranchi	0-1	1987.10	1,02,000	10.93	39.93
	1-2	3918.40	70,600	21.55	27.64
	2-3	3179.20	25,600	17.49	10.00
	3-4	2037.60	33,000	11.21	12.92
	4-5	3690.40	20,200	20.29	7.93
	5-6	3370.20	4,000	18.53	1.58
Total		18182.90	2,55,400	100.00	100.00
Gaya	0-1	2003.10	96,800	26.56	53.77
	1-2	3740.80	74,600	49.61	41.44
	2-3	1796.80	8,600	23.83	4.79
Total		7540.70	1,80,000	100.00	100.00
Bhagalpur	0-1	1861.70	78,800	25.18	45.71
	1-2	3003.50	47,400	40.63	27.49
	2-3	2107.20	37,600	28.51	21.81
	3-4	419.80	8,400	5.68	4.99
Total		7392.20	1,72,200	100.00	100.00

TABLE 4.1—*Contd.*

1	2	3	4	5	6
Darbhanga	0-1	1705.50	58,200	34.86	44.29
	1-2	2280.14	55,800	45.58	42.47
	2-3	781.12	15,800	15.97	12.02
	3-4	102.00	1,600	2.66	1.22
Total		4886.76	1,31,400	100.00	100.00
Muzaffarpur	0-1	1908.35	88,400	43.09	70.15
	1-2	2332.00	37,600	54.54	29.85
	2-3	103.20	—	2.37	—
Total		4343.50	1,26,000	100.00	100.00
Monghyr	0-1	1660.60	75,400	41.77	73.50
	1-2	1690.00	22,000	42.52	21.45
	2-3	624.60	5,000	15.71	5.05
Total		3975.20	1,02,400	100.00	100.00
Biharsharif	0-1	1467.60	55,620	35.45	55.59
	1-2	1514.40	36,220	36.58	36.20
	2-3	1158.00	8,206	27.97	8.21
Total		4140.00	1,00,046	100.00	100.00

Source : Data computed by the author.

the chief commercial hub of the city but relatively more dominant centres of population and commercial activities developed at a distant place. These cities are, therefore, characterized by dualism and reveal binodal profiles.

A more or less similar trend of density pattern is found in Ranchi and Biharsharif. In the case of Ranchi, the focus of population concentration is around the principal commercial belt of the city from where the density curve slopes downward, but after three miles and a half it shows a rising trend and thereafter falls to the periphery. A typical fluctuation in density curve in the marginal area is largely due to sporadic growth of industries at the city suburb. In Biharsharif, a similar fluctuation in density curve is caused by the recent growth of a large business '*maundi*' at Sohsarai (Karunabagh) which is principally encouraged by potato (a cash crop) cultivation. The chief centre of population concentration is, however, around the old city chowk (Poolpar) in Biharsharif. A different configuration is observed in the case of planned city of Jamshedpur, where because of controlled land use development, residential segregation has not been allowed to grow. The density in general is very low as compared to other cities of Bihar. The gradient pattern after a slight downward shift in the first mile, remains constant for the next three miles and later sharply slopes to the city limit.

Regression Analysis

From the inspection of Table 4.2 it becomes apparent that the coefficient of correlation in the cities of Bihar vary between 0.56 for Jamshedpur to 0.98 for Gaya. Some of the highest correlations are found in relatively small size cities like Gaya, Darbhanga, Muzaffarpur and Monghyr. The population densities in these cities reach the peak in the single central core area and a sharp gradient slopes down to the sparsely populated periphery. Having originated during the 17th and 18th centuries as centres of administration, these cities have a predominantly administrative functional character which confined their growth to a small compact area with a thickly settled city centre. The density in the heart of these traditional cities ranges between 100 to 250 persons per acre which in the marginal wards after a few miles from the centre may fall below 10 persons per acre. The ratio of gross density between the central and peripheral areas is usually more than 15 : 1 and in any case not less than 5 : 1. Breese also observed striking contrasts between densities of inner and peripheral wards in 13 large Indian cities. In 'British developed cities', (Bangalore, Bombay, Calcutta and Madras) the ratio differences in persons per inner and peripheral square mile range from 3 : 1 to 5 : 1 while in 'Pre-British period developed cities' the ratios are Allahabad-6 : 1, Varanasi-8 : 1, Baroda-9 : 1, Delhi-13 : 1, Hyderabad-4 : 1 and Poona-8 : 1.[14] The scatter diagrams (Fig. 4.4) show that the central wards with small areas and high densities are clustered within one mile distance from the city centre in which some of the most crowded wards are found above the regression line and even sometimes above the confidence limit. It is highly noteworthy that the general density gradients when treated in terms of the linear regression (Least Square Fit) show higher correlation and higher level of statistical significance in these cities than other categories. Except for Patna (0.67), Jamshedpur (0.56) and Bhagalpur (0.57) where because of relatively high degree of dispersion in population distribution, the coefficient of correlation is low (below 0.70), in the other six cities of Bihar it is much higher. A closer examination of the diagram reveals that maximum densities may not necessarily exist in the central commercial areas, although in India, the traditional central *bazar* is characterized by relatively high densities.[15] In contrast to western countries, cities in India have a traditionally mixed residential and commercial land use in the central parts of the city.

The population density pattern markedly differs in cities characterized by dual population centres. In the case of Patna and Bhagalpur, the density gradient slopes steadily in the first mile from the centre but tends to flatten afterwards which reflects tendency towards dispersion of population. The central densities computed by estimating equation show consistently lower level of population density than those analysed in group 'I' cities. The traditional tempo of residential segregation in the city

TABLE 4.2 : **Regression of Gross Population Density Patterns in the Cities of Bihar, 1971**

Cities	Statistical zones	Estimating equation			Persons per acre (distance in miles from city centre)									Coefficient of correlation	Coefficient of determinants	F ratio
		Log a	Log b	Log yx	0	1	2	3	4	5	6	7	8			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Patna	14	1.83770	−0.08445	0.6530	68.80	56.62	46.56	40.17	31.56	26.00	21.42	17.63	14.53	0.67	0.45	0.01
Jamshedpur	10	1.44837	−0.1108	0.3760	28.07	21.75	16.85	13.05	10.11	7.76	6.02	—	—	0.56	0.31	—
Ranchi	10	1.67805	−0.1955	0.2372	47.64	30.37	19.36	12.34	5.01	—	—	—	—	0.78	0.60	0.01
Gaya	6	2.09328	−0.6029	0.1900	123.94	30.92	7.71	—	—	—	—	—	—	0.98	0.96	0.01
Bhagalpur	7	1.59447	−0.1346	0.6655	39.30	28.83	20.66	15.51	11.37	—	—	—	—	0 57	0.32	—
Darbhanga	7	1.68900	−0.1756	0.1970	48.86	32.61	21.76	14.52	9.68	—	—	—	—	0.95	0.90	0.01
Muzaffarpur	5	2.16569	−0.8170	0.0490	146.46	22.82	3.40	—	—	—	—	—	—	0.96	0.92	0.01
Monghyr	5	1.87780	−0.4595	0.2370	75.47	26.20	9.09	—	—	—	—	—	—	0.98	0.96	0.01
Biharsharif	5	1.72916	−0.2196	0.3294	53.60	32.32	19.49	11.74	—	—	—	—	—	0.86	0.76	0.05

Source : Data Computation by the Author.

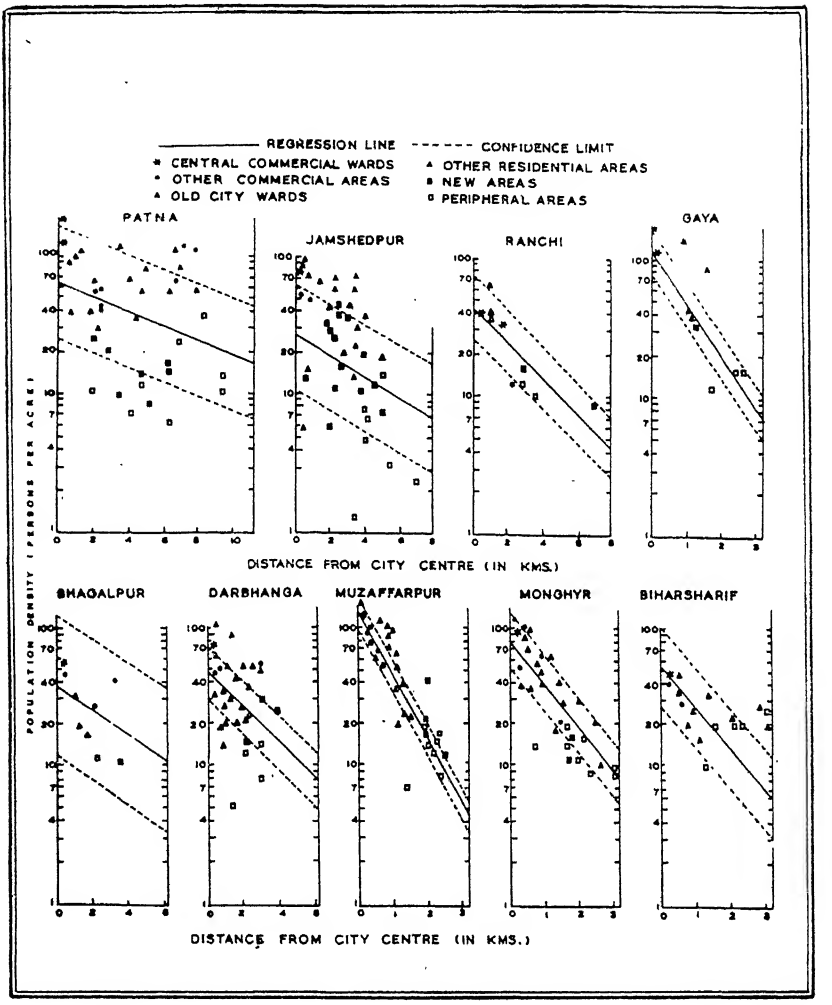

FIG. 4.4 : *Density-Distance Relationship*

centre is no more experienced in large cities and the recent tendency is towards dispersion rather than concentration in the city centre.[16]

The examination of the density map (Figs. 4.5 and 4.6) also brings out some of the salient features of population distribution pattern in dual centred cities. In Patna, for example, the centre of population concentration lies at Muradpur, the principal commercial area of the city which is only three miles upstream along the bank of the Ganga from the old Patna city, a secondary population centre. The density of population in the central zone varies from 100 persons per acre which gradually declines and thins out to less than 15 persons per acre in the marginal wards. The

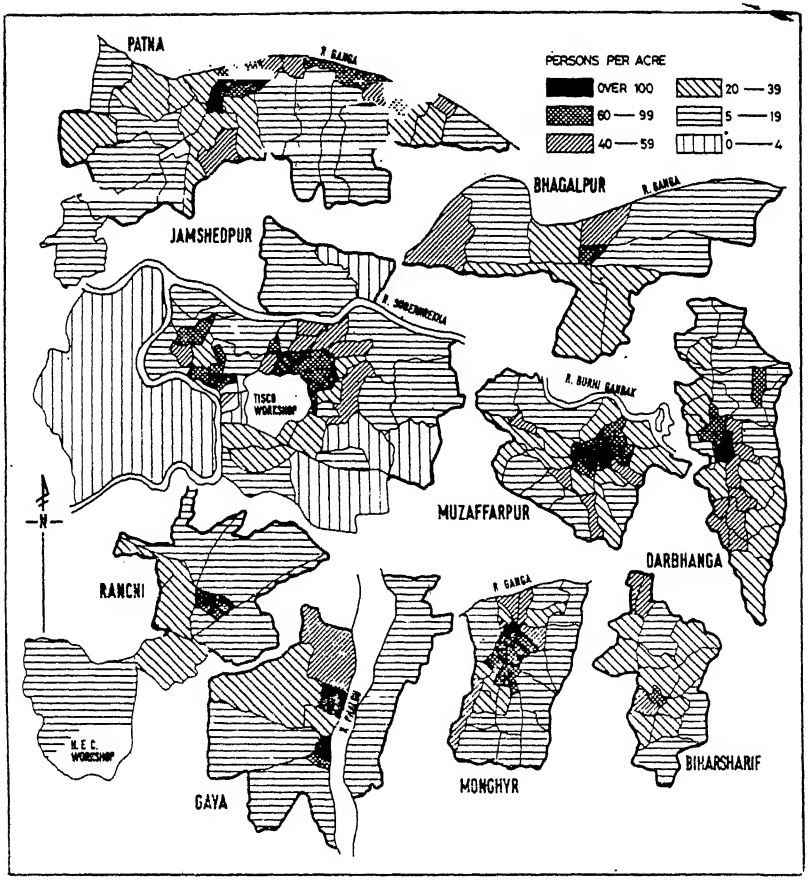

FIG. 4.5 : *Population Density (by wards 1971)*

density-distance gradient drawn on semi-logarithmic scale appears to be comparatively flattened which is due mainly to the existence of sub-centres of population concentration. Brush[17] also observed similar characteristics of population density patterns in many other cities like Hyderabad-Secunderabad, Bangalore, etc.

In Bhagalpur, area surrounding Suzaganj commercial zone with population density over 70 persons per acre is dominant over the old city centre at Champanagar-Nathnagar which is a secondary centre of population. The coefficient correlation (0.57) and coefficient of determination (0.32) are extremely low which indicates that the variance of population density pattern is less effectively explained by the distance from the city centre. Similarly, in Ranchi the focus of population concentration is found close to the principal commercial zone along the main road where the

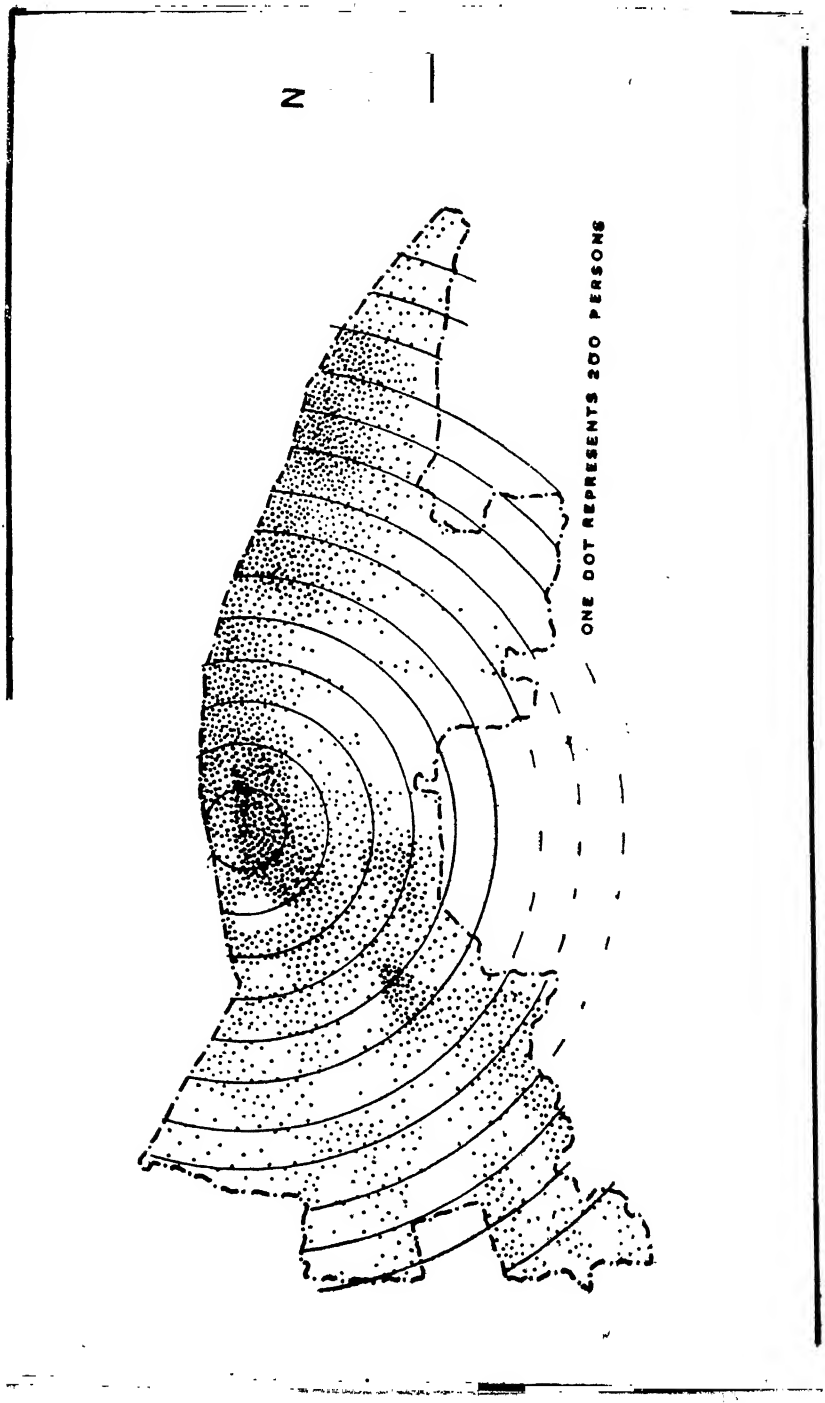

FIG. 4.6 : *Distribution of Population of Patna (1971)*

overall density ranges between 50 to 70 persons per acre. The density profile slopes downwards and a slight inverse trend is observed in the fringe area which may be accounted for by the massive industrial growth in Jaganathnagar and Doranda. These two satellite towns in t' e city suburb together accommodate nearly one lakh inhabitants. In Biharsharif, the centre of residential segregation lies at the traditional Chowk Bazar from where the density gradient declines outwards and a newly developed business area at Sohsarai forms a secondary population centre.

In the planned city of Jamshedpur, the results show a uniform density-distance profile. The coefficient of correlation is the weakest (0.56) which means that the variance of population density is not fully accounted for by the distance from the city centre. The diagram shows a generally low level of population concentration varying between 60 and 90 persons per acre in the central wards and between 5 and 10 in the fringe areas. Unlike other large traditional cities, Jamshedpur has not developed any specialised commercial zone. The city centre is, however, the old commercial area of Sakchi while Bistupur is the modern and western style developed market zone of Jamshedpur. The profile shows a moderate fall of density in the first mile from the centre and remains more or less constant in the next four miles and then drops sharply to the periphery. The overall plateau shaped density profile is highly noteworthy. Because of controlled land use development, the expansion of residential area has been kept highly dispersed and not allowed to concentrate in specific locality. Thus, the urban-industrial complex has remained a garden city largely free from congestion, so commonly found in the majority of Indian cities.

Deviation of Residuals from Regression

Analysis of regression line and coefficient of correlation computed by estimating equation only shows the trends of density gradient pattern and does not adequately reflect the observed population variation. Thus, a line joining different fluctuating points of population densities is more significant than the straight line based on simple regression analysis (Least Square Fit). The extent of spatial variation of population density from the city centre may be understood by detailed description of residuals from regression. In Fig 4.4, the actual densities calculated for the cities wards appear in a logarithmic scale on the vertical (y) axis in relation to distance from the centre in miles on the horizontal axis (x). It reveals that the central statistical units having the highest density per acre tend to cluster within the first mile from the centre with some of them lying above the regression line and even a few of them beyond the standard error of estimate. The technique of mapping of residuals from regression was advanced by Robinson[18] with his associates which provides us the way to emphasize the peaks of islands

of population densities especially where the statistical units fall above the confidence limit (Fig. 4.7). In Gaya, for example, the central wards (2, 3, 5 and 6) facing the riverside location along the Phalgu (between Bari Road and Rangbahadur Road) are most crowded and are within the first mile and a half from the city centre, placed at the crossing roads to the west of City Tower in Sahibganj commercial area. The densities in this core of the city vary between 100 and 250 persons per acre which declines to about 10 persons in the outlying wards. The predominant features of the old city popularly known as 'Ander Gaya' are slum condition attained with both horizontal and vertical development. The densities of population are, however, not as high as those found in Delhi, Kanpur and Hyderabad where because of comparatively more vertical residential growth in the central zone, population per acre is over 400.

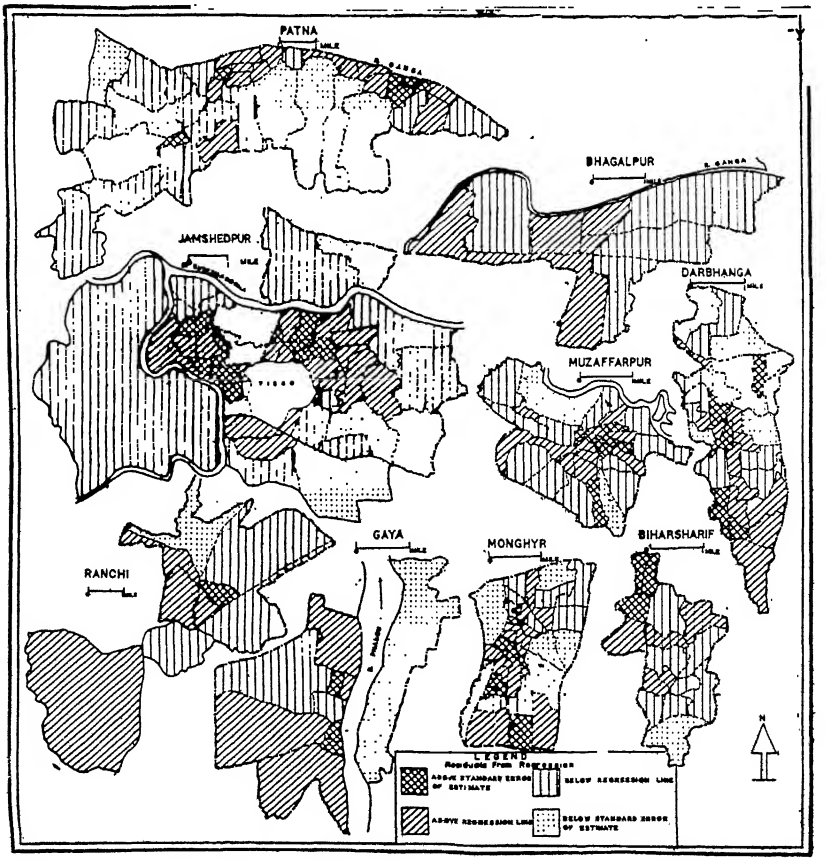

FIG. 4.7 : *Residuals from Regression of Population Density in Cities of Bihar (1971)*

Unlike western cities, the commercial zone is not free from residential uses and except for the front foot portion of the building along the roads, devoted to commercial utility, the adjacent lands of the same apartments are extensively given to residential purposes. The density figure in some of the census tracts rise to such an extent as to lie above the estimating line and above the confidence limit while some others with moderate population are below the regression line. Because of high coefficient correlation (0.98) and high coefficient of determination (0.96) with F ratio exceeding one per cent level, the degree of dispersion of population densities is

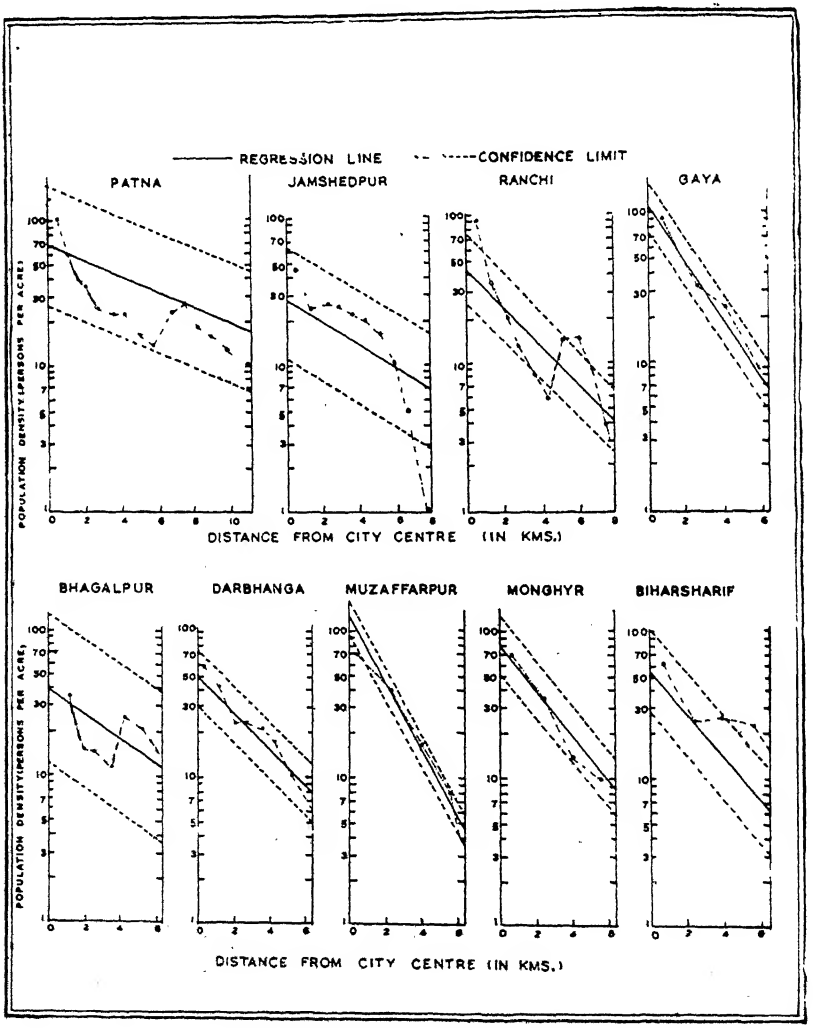

FIG. 4.8 : *Density of Distance Increments of Cities of Bihar (1971)*

comparatively low and the statistical units tend to follow the regression line. This means that 96 per cent of the variance of population densities is explained by distance from the city centre. The density drawn along the estimating line is higher in the first mile and slopes down in the later half which again rises after a mile and a half, and lastly, goes down in the outskirt (Fig. 4.8).

The geographical interpretation of spatial variation of population in Darbhanga, Muzaffarpur and Monghyr shows similar basic features. The heart of these traditional cities bears very high concentration of population and residential land use is mixed up with commerce and other activities. In Darbhanga, because of linear north-south expansion of the city along the little Baghmati and due to its frequent marginal inundation, some of the areas though very close to the centre, have extremely low population. The dispersion diagram shows that thickly populated units (8, 14, 18 and 26) consisting of Lakhminagar, Katabari, Maroof Bazar and Bhagwandas Road, etc., are above the regression line with a few of them above the confidence limit. These localities together have an average density of 83.45 persons per acre. The density profile according to distance increment shows a sharp fall of density in the first mile and a half and then it rises up to the standard error of estimate and after that it slopes down to the line of confidence limit.

Analysis of net residential densities pattern in Gaya and Darbhanga for which ward-wise data have been worked out, further elucidates our understanding of the intra-urban variation of population in the cities of Bihar. The data presented in Table 4.3(a) and 4.3(b) are adequate to provide comparative account of the gross and net residential density patterns in these cities. It is noteworthy that net residential densities are much higher in each and every municipal ward than the gross densities and a

TABLE 4.3(a) : **Gross and Net Residential Population Density (1971) (Gaya)**

Ward No.	Area (in acres)	Population (1971)	Gross pop. density	Net residential density
1	2	3	4	5
1	692	30,408	40.94	91.61
2	74	9,497	126.17	201.22
3	75	15,159	202.12	308.18
4	1,272	45,699	36.48	56.42
5	172	6,808	38.41	63.17
6	68	10,023	162.10	215.21
7	76	7,097	93,38	203.27
8	1,124	10,949	15.07	37.20
9	1,332	22,399	16.81	34.18
10	1,950	21,845	11.20	31.25

tendency towards centralisation is more acute. The proportion of land put to residential uses is maximum in the central units in relation to its total area (Fig. 4.9). In other words, the built-up area in the centre is more compact than in the outlying areas. The net residential densities if measured by distance increment from the centre shows maximum concentration and a rapid declining trend in the outer fringe areas.

TABLE 4.3(b) : **Gross and Net Residential Population Density (1971) (Darbhanga)**

Ward No.	Area (in acres)	Population (1971)	Gross pop. density	Net residential density
1	2	3	4	5
1	260.62	2,595	9.94	44.10
2	230.68	3,652	15.76	72.25
3	250.25	3,298	13.19	71.40
4	102.50	3,310	32.45	75.28
5	72.81	3,186	43.64	91.44
6	492.42	2,605	5.18	11.05
7	230.90	3,676	15.90	52.13
8	47.00	4,030	85.90	171.10
9	284.53	4,566	16.02	45.15
10	159.83	3,038	18.98	22.18
11	125.46	3,578	28.62	45.26
12	120.57	4,056	33.52	97.32
13	71.51	2,360	32.76	95.30
14	51.08	4,326	80.00	120.70
15	76.51	4,067	52.81	84.46
16	190.51	3,806	20.00	57.24
17	80.47	4,061	50.76	74.45
18	42.73	4,717	109.69	115.80
19	65.30	4,141	63.70	96.60
20	124.91	2,426	19.40	43.18
21	186.41	5,695	30.61	93.25
22	91.79	4,875	52.96	89.20
23	165.13	3,322	20.14	67.25
24	203.62	4,170	20.38	25.16
25	77.63	4,545	58.27	75.44
26	80.54	4,255	52.53	105.40
27	102.00	4,181	40.99	56.45
28	207.83	5,315	25.55	45.24
29	170.33	5,177	31.04	38.35
30	85.94	4,735	53.89	116.56
31	82.51	4,875	58.73	78.50
32	359.90	9,421	26.17	37.22

Source : Computation of density data by the author.

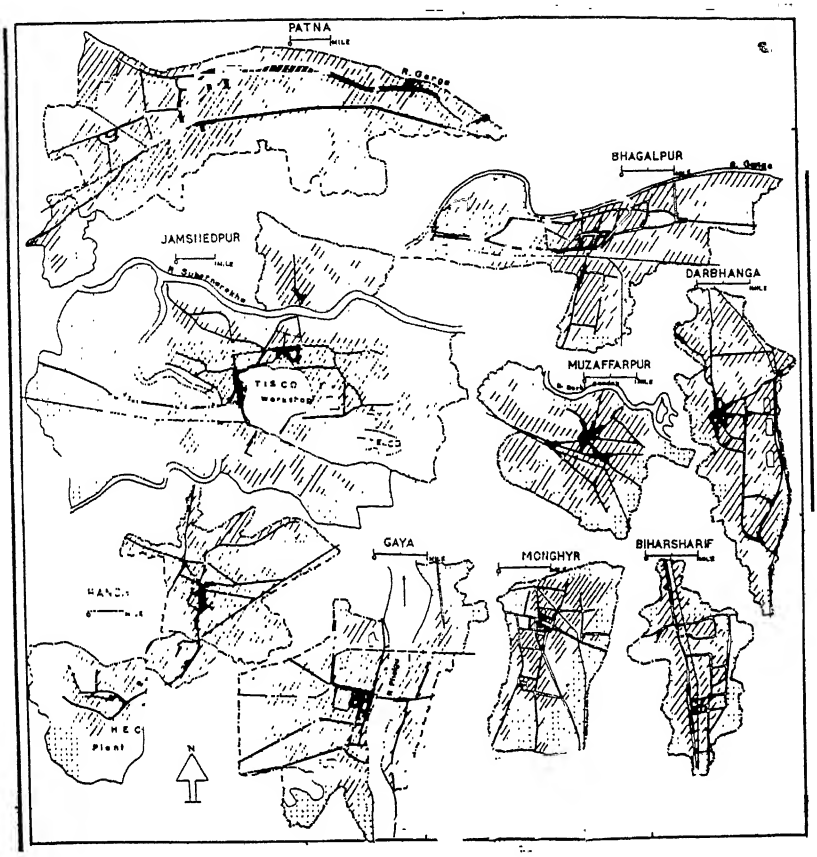

FIG. 4.9 : *Residential Land Use in Cities of Bihar (1971)*

Tables 4.3(a) and 4.3(b) show ward-wise data of gross and net residential density pattern in Gaya and Darbhanga in which maximum residential density occurs in the central bazar. The spatial relationships may be interpreted in the following way.

In the heart of these traditional cities of Bihar with typically mixed residential and commercial land uses, residential areas have partly been displaced by commercial and other activities which are sufficient to reduce the gross density of population. In Gaya, the densities in the most crowded central wards (2, 3, 6 and parts of 4 and 5) varies between 100 to 200 persons per acre, while the net residential densities of those areas are much higher, i.e., between 200 and 310 persons per acre. In Darbhanga, the maximum density can be seen in wards 8, 18 and 26 comprising the localities of Lakhminagar, Katalbari, Abdulaganj, Dildarganj, Maroof Bazar, etc. In these central wards, the overall densities are 86, 110 and 75

persons per acre while the net residential densities are 171, 116 and 75 respectively. Immediately outside the old city specially in the areas of recent development, the net residential densities fall below 25 persons. The outermost areas around these cities, in fact, comprise vast cultivated land, open spaces, water bodies, etc., which explain the low level of density per acre. Similar density patterns in majority of the cities of Bihar are most likely to be found because of similar character of their origin and growth trends.

Deviation of residuals from regression line in Muzaffarpur is still more apparent than in Darbhanga. The thickly populated census units are clustered within a mile radius from the city centre, placed at Saraiyaganj chowk. Choti Kalyani, Chandwara and adjacent areas appear to be old nucleus of the city where man-land ratio is at peak, i.e., on an average 110 persons per acre and declines rapidly to the city suburb. High correlation (0.97) and high level of statistical significance (0.01 level) show that there is a causal relationship between density and distance from the city centre. A closer examination of the density profile according to distance increment reveals that the observed values are found along the estimating line with minor deviations.

Observation of density pattern in Monghyr is basically the same as in Muzaffarpur. Areas of maximum residential and commercial segregation are found in adjoining areas to the east of the ancient fort where population density in some of the census tracts are at the point of saturation, the figure being around 300 persons per acre. Outside the old city the density declines to less than 15 persons per acre in the fringing wards. Areas surrounding the city centre are moderately populated, with 80 to 100 persons per acre (in 16, 17, 18, 19 and 20 wards). The scatter diagram shows that the census tracts with high population per acre are found within a mile distance from the city centre in which the most crowded residential units (9, 17 and 19) are found above the confidence limit (Fig. 4.4).

The spatial pattern in the dual central cities differs markedly from those observed in the above cities; firstly, in their general low density level and secondly, in a tendency towards dispersion rather than concentration.[19] Examination of deviation graph and density map reveals the fact that central tendency is no longer a basic consideration for residential location when the city is small, homes tend to cluster close to the dominant business centre for convenience. As population increases and requires more homes, some few will be built among the existing dwellings but a larger number will be located on vacant land towards the outskirt.[20] In other words, as the city continues to grow the greater proportion of new buildings continues to be erected on the less intensively utilized land of the outer zones.

The results show that coefficient correlations and coefficient of determinations are low in comparison with the cities characterized by single predominant population centre. Patna, for example, with its adjoining townships of Patliputra and Phulwarisharif presents an even more complex pattern than Bhagalpur, Ranchi and Biharsharif. The urban area with a radius of about 7 miles and a half from the centre and a population of nearly half a million is the largest city in the State. The map of population density according to 37 municipal wards with their adjacent urban areas show a wide variation of population distribution ranging from about 100 to 250 persons per acre in the central units to less than 15 in the outlying city fringe areas. The highest concentration is found in the principal commercial area of Muradpur (wards 15 and 16) and its adjacent areas to the east, south and south-west (e.g., Langartoli, Machhuatoli, Sabzibagh, Bakarganj, etc.) The coefficient correlation (0.67) and coefficient of determination (0.44) are relatively low and *F* ratio exceeds five per cent level which are indicative of the fact that dispersion rather than concentration has been a recent phenomenon in the distribution of population. The scatter diagram also shows clustering of the central wards and a low range of deviation from the regression in the first two miles from the centre while it widens after three miles which further indicates that complexity in density pattern increases with the increase of distance. The positive deviation of residuals from regression at a distance of 4 miles from the city centre shows that census units in old Patna city having densities between 80 and 150 persons per acre are above the line of standard error of estimate while in some others especially Patna administration areas in the west and a few undeveloped areas in the south-east, densities are so low (between 5 and 15 persons per acre) as to fall below the confidence limit.

In Ranchi, the overall distribution of population and density pattern are similar to those in most Indian cities, viz., heavy centralisation of population at the traditional heart of the city with declining density as distance from the city centre increases. The urban area of Ranchi besides its municipal limit, also comprises vast tracts of Jaganathnagar and Doranda industrial complex which together form a large urban agglomeration having 2.55 lakh city dwellers. The complexity in density pattern at the marginal areas of Ranchi has been caused by emergence of the above two industrial towns. The statistical units when arrayed along the regression line constantly follow a straight course upto a distance of 4 miles from the centre and later because of increase of population densities, deviations widen appreciably. The map of population distribution indicates how strongly population is concentrated within the old city area, i.e., Purana Ranchi, Hindpuri and Kasaimohalla, etc., which are in a state of obsolescence. The map of residuals from regression further reveals that

the most pronounced excess of concentration occurs at the centre in close vicinity of the CBD.

Observations in Bhagalpur show that residential crowding occurs all around the principal Suzaganj commercial zone which developed in a limited compact area. The concentration of population adhering to this central core is mainly due to the high business return and employment opportunities. Thus, the density in the first quarter of a mile is relatively low but suddenly shoots up from about 60 to 70 persons per acre in the later half a mile. Mundichak, Mirjan, Aliganj, Tatarpur, Ramsar and Laheritola, etc., are some of the important localities which have virtually turned into slum condition. The density profile declines in the first three miles from the centre but a inverse tendency is traced afterwards because of the existence of the old city centre at Nathnagar-Champanagar which has been specialising in weaving and spinning activities on domestic level. The scatter diagram which shows greater residual deviation in the marginal area of the city, also confirms the idea conceived above.

The population density pattern in the historical city of Biharsharif is more or less comparable to that of Bhagalpur. Athough the city has a great antiquity, its growth until recently remained neglected and it is only in the last decade (1971) that the place could attain the status of a city with slightly more than one lakh inhabitants (1,00,046). During the last few decades, the city has come into prominence because of agricultural development in its adjoining region and also due to the opening of a number of government offices and educational institutions. The spatial distribution of population in the city shows central tendency of population concentrations, i.e., from 50 to 60 persons per acre in the centre and 10 to 15 persons at the margin. The density curve slopes downwards from the city centre, taken at the main traditional *bazar* in Biharsharif but a slight upward trend is noteworthy because of the existence of a sub-centre of population in Karunabagh (Sohsarai).

The industrial city of Jamshedpur with its adjacent townships of Adityapur, Baghbera, Jugsalai and Kalimati, has an urban area of about 28,770 acres and a population of 4.56 lakh in 1971. The city started growing with the very inception of the main steel plant (TISCO) in 1907 and since then, the development of the city has been made strictly on the basis of planning schemes designed by several engineers and planners. The map of population distribution and the scatter diagrams reveal the fact that there has been relatively low level of concentration of population in the central commercial wards. Because of planned development since its evolution, the residential land use has been kept highly dispersed. The reason for low general population densities in Jamshedpur is the enforcement of checks on the sporadic growth of the built-up area in the TISCO owned areas and the BNR colony. Relatively high degree of dispersion of

the census units as plotted along the regression line also justifies the above fact. The densities of population in 42 statistical areas shown in the map (Fig. 4.5) varies from 60 to 80 persons per acre around the commercial zone and 5 to 10 persons in sub urban tracts. In Jamshedpur, some of the most densely populated areas lying to the north-east and east of TISCO are Kasidih, Sitaramdera, Old L Town, East plant *busties*, etc. In the adjoining urban areas of the city, the maximum density occurs in Jugsalai with 30 persons per acre, followed by Baghbera, Kalimati and Adityapur with 12, 5 and 4 persons per acre respectively. The map of residual from regression reflects the fact that because of very high range of deviation, most pronounced positive residuals are found in surrounding areas of TISCO main plant while the negative residuals are mostly in the fringing areas of the city.

From the above description, one thing stands out clearly that the pattern of population variation within cities is related in some manner to the structure of urban land use. If such is the case, certain aspects of the distribution of land use may be used to describe and explain the spatial variations of population distribution. A few aspects of land use structure such as land values, business structure, per capita income distribution, potential of land values, etc., may be taken to examine the validity of the model described. Because of non-availability of the basic data on spatial structure, it has been found necessary to employ household data available in the census. The pattern of residential household is a good indicator of concentration and dispersal of population within cities. The spatial variation varies directly with the variation of residential households within cities.

A critical appraisal of the two sets of map, i.e., density of population and density of houses (Fig. 4.10) reveals the following facts. In the cities of Bihar, obviously high density of population invariably corresponds with high density of houses. It has been found that segregation of a large number of residential units within a limited civil ward area, marks the compact and congested residential structures. The factor which makes an area high or low class residential areas can be estimated by the size of the households and the availability of open spaces in the area. From this point of view, it can be marked that in Patna, the proximity of the Ganga bank shows the highest density of population and residential houses (from Bankipur to Patna city along the Ashok Rajpath) i.e., from 60 to 200 persons and 10 to 25 houses per acre respectively. This also suggests that the house units are covering less space and the open spaces are comparatively insignificant. Outward to this zone though the population density is fairly high, i.e., 40 to 100 persons, yet the spacious and larger houses in this area have made it a middle class residential area. Besides, densities are also high in some localized parts such as Mithapur, Jakanpur and

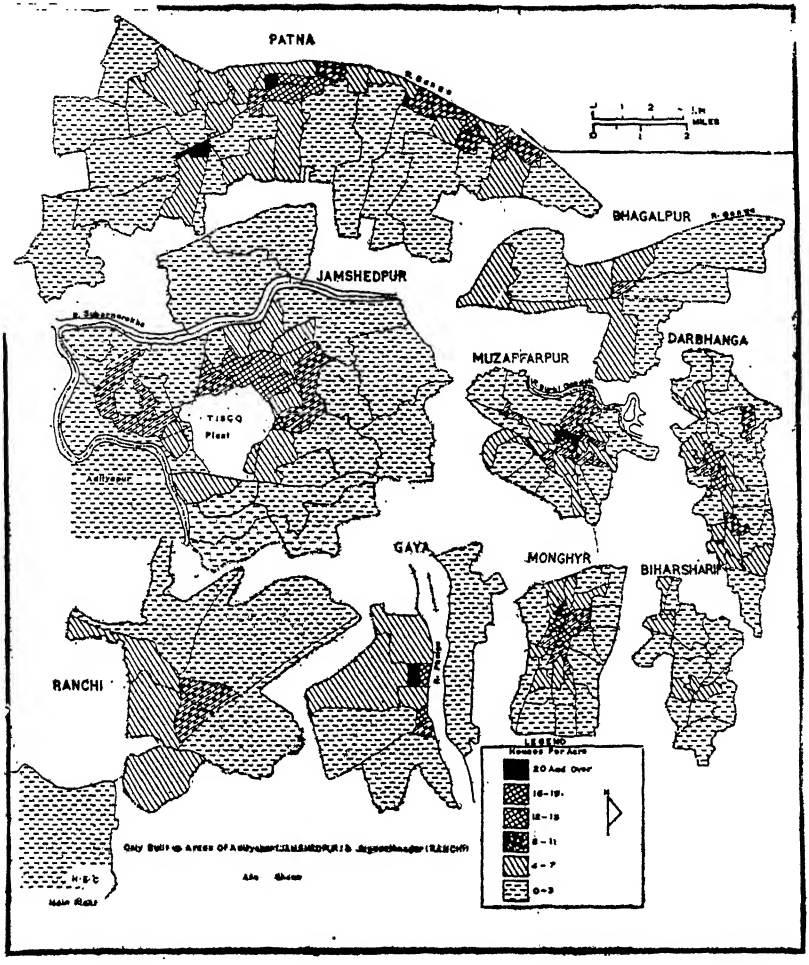

FIG. 4.10 : *Density of Residential Houses in Cities of Bihar (1971)*

Rajapur-Manpura areas of the city with 150 persons and 25 houses per acre. In the outer zone of the city comprising Rajendra Nagar, Kankarbagh, West Administrative area, Rajbanshinagar, Shrikrishnapuri and Patliputra colony, etc., the area is characterized by low housing density and a sparse population. These localities are, therefore, classed as good residential areas of the city.

Almost similar observations can be made for other cities of Bihar. It can be traced out that the area characterizing high density of population are also areas of high density of houses. The map shows that the original nucleus of all the cities are occupied by low class residential areas which

means high densities of population and houses per acre. In Ranchi, for example, the old city area has maximum densities of houses and population (i.e., 8 to 10 houses and 60 to 70 persons per acre) whereas the density outside the central area diminishes remarkably. In Gaya, the residential crowding is found along the west bank of the Phalgu, the average figure being 14 houses and 115 persons per acre. Similarly, in Bhagalpur, Darbhanga, Muzaffarpur, Monghyr and Biharsharif, huge residential segregation of houses corresponds to the traditional old *bazar* where centralisation of population is also maximum (Fig. 4.11). The density in this area ranges between 8 and 15 houses and 60 to 80 persons per acre. Since the cores of these cities are the main commercial and business areas characterising multistoreyed buildings, narrow lanes and streets, the localities may be classed as comparatively low class residential areas. The spatial pattern of residences have pronounced concentration of multifamily buildings near the business centre along the certain radial streets that extend outward from it.[21]

In the industrial city of Jamshedpur, picture is relatively different because of different land use structure. The most apparent fact in Jamshedpur is the comparatively small area in low class residences and rather a high percentage under high class residences. This character of the city is largely due to planned development of the residential and other areas by TISCO and other companies. These have developed a number of residential colonies like Baghbera, Gobindpur, TELCO colony, Adityapur, etc., in different parts of the city. To ease the problems of housing, the State government also stepped forward by launching a medium and low income housing programme in the city. The overall density pattern is, therefore, low in comparison with other cities of Bihar.

While summarising the density patterns in the cities of Bihar, it is desirable to highlight some of the salient features of population distribution.

Spatial variation of population in the cities of Bihar follows an empirical regularity long established by Clark and elaborated by Berry and others. Any deviation from the original model may be attributed to a number of local disturbing factors. Observations have shown (Chapter 5) that geographical, historical, economic and social factors have largely been responsible for the existing patterns of spatial distribution of population in the cities of Bihar. As a result of complete absence of planning, these cities, as in the case of the majority of Indian cities, have flourished in a most haphazard way in which central tendency of population distribution has dominated the urban scene. The study of density graphs shows that the cities characterized by single predominant population centre have steeper gradient than those having bi-nodal population profiles.

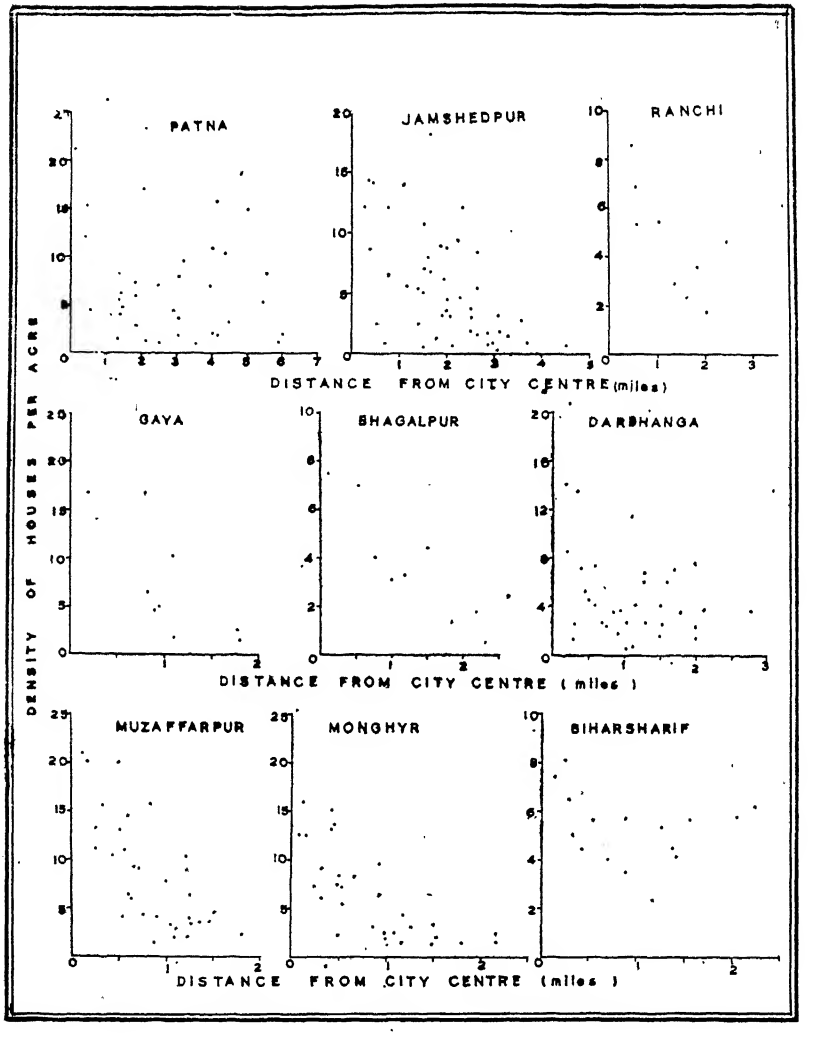

FIG. 4.11 : *Scatter Diagram—Density by Distance Increments*

The density gradient pattern in the planned city of Jamshedpur is very distinct from other cities in Bihar because of quite distinct internal structure. Owing to the planned and controlled land use development from the very beginning, the population density in general is very low in comparison with other cities.

The smaller cities have steeper population density gradients which tend to flatten gradually with the increase of sizes through time. With the growth of city size through sequential stages of development, it would

appear that the majority of cities in the State would go through a stage of intensive land use and population concentration before outward expansion and population dispersion.

The central densities in the cities of Bihar are not as high as the large Indian cities like Delhi, Kanpur, Hyderabad, Bangalore, etc., where residential buildings have comparatively more vertical growth and are characterized by multi-storeyed and multifamily systems. However, multistoreyed houses are not very large in number in the medium and small size cities. The single and double storeyed houses have now been converted into multi storeyed ones to compensate for the lack of horizontal space.

REFERENCES

1. Steward, Q.J. and Warntz, W., Physics of Population Distribution in 'Spatial Analysis': A Reader in Statistical Geography, (Ed. by Berry J.L. Brian and Marble F. Dune), Prentice-Hall Englewood Cliff, New Jersey, 1968, p. 130.
2. Clark, Colin, Population Growth and Land Use, Macmillan, London, 1967, p. 341.
3. Quoted by Brian J.L., Berry *et al.*, Urban Population Densities: Structure and Change; Geographical Review, Vol. 53, 1963, pp. 389-90.
4. *Ibid.*
5. Kar, N.R., Growth, Distribution and Dynamics of the Population Load in Calcutta, 1962 (Memeographed).
6. Quoted by Bruce, E. Newling, The Spatial Variation of Urban Population Densities, Geographical Review, Vol. 59, 1969, p. 243.
7. Clark, op. cit., p. 349.
8. *Ibid.*, pp. 389-405.
9. *Ibid.*, p. 395.
10. *Ibid.*, p. 403.
11. Brush, J.E., Spatial Patterns of Population in Indian Cities, Geographical Review, Vol. 58, 1968, pp. 362-401.
12. Brush, J.E., Application of Model to the Analysis of Population Distribution in Indian Cities (Ed. by R.L. Singh), Urban Geography in Developing Countries, N.G.S.I., Varanasi, 1973, pp. 28-49.
13. Kenney, J.F. and Keeping, E.S., Mathematics of Statistics, East-West Edition, New Delhi, 1964, Chapters 15 and 16.
14. Breese, G., Urbanisation in Newly Developing Countries, Bureau of Urban Research, Princeton University, Prentice Hall, Englewood Cliff, 1966, p. 72.
15. *Ibid.*
16. Singh, R.D., Demographic Structure of Gaya: Indian Geographical Studies, Bulletin 4, 1974, p. 48.
17. Brush, J.E., op. cit.

18. Robinson, H.A. and Bryson, A.R., A Method of Describing Quantitatively The Correspondence of Geographical Distribution, Annals of the Association of American Geographers, Vol. 47, 1957, pp. 379-91.
19. Brush, J.E., op. cit., p. 33.
20. Quinn, A. James, op. cit., p. 90.
21. Taneja, Kusum Lata, Morphology of Indian Cities (Ed. by R.L. Singh), Silver Jubilee Pub., National Geography Society of India, Varanasi, 1971, p. 75.

5

FACTORS AFFECTING POPULATION DENSITY PATTERNS

THE SPATIAL variation of population within cities is the result of interaction of a large number of factors. These may broadly be classified as historical, physical, social and economic. The age of cities and the process of their growth have the most obvious influence on population concentration near the city centre. In olden days, people because of several reasons (i.e., security, religious conviction, accessibility, etc.) preferred to reside as closely as possible in a compact area making it a complex and confused nucleus with a very high population density. Hawley while describing intra-urban variation of population across metropolitan areas, stated that population growth intensifies the struggle for central location as the demand for land far outturns supply.[1] This process might have two consequences. First, central residential land in particular would be sub-divided so that the individual can afford rent. This would result in a general pattern of population concentration towards the CBD. Second, the overall density level and congestion may increase due to general shortage of land. With the tendency for people to reside and work in the same area, this has generally resulted in heavier concentration of population in the central wards of the city.[2] Older cities built with small lots and sub-divisions will have higher densities than cities built at other times with other modes of development.[3] A majority of large Indian cities are ancient in origin in which the history of their growth has played a vital role in the concentration of population towards the city centre. The old city centre of Gaya known as 'Andar Gaya' may be cited as an example where the residential structures are most complicated and built in a haphazard fashion. Buildings are very old and tall often separated from one another by thin dark corridors and streets and lanes are congested, extremely narrow and crooked. Thus, the overall picture that can be observed is highly chaotic and unhygienic.

During historical periods, cities in India passed through many important vicissitudes under the hands of the emperors, who at the seat of their administration often erected garrisons and lofty fortifications.[4] People because of greater assurance of security settled in the vicinity of the fort. Soldiers and retainers, merchants and craftsmen crowded inside the walls for military protection and safety from robbers.[5] Thus, in surrounding areas of the nucleus of ancient forts in Patna, Bhagalpur, Darbhanga and Monghyr, some extraordinary pressure of population on land exists.

In British period, the centre of population concentration shifted at a distant place (nearly two to four miles away) from the old city centre because of the impact of British administration. Britishers as a result of western culture and tradition, could develop the area in planned way which later became the focus of attraction for people of higher income groups. The principal commercial area which was confined to the old city chowk, was also shifted as a consequent to the growth of the new city centre. In Patna, Bhagalpur and many other British built cities in India, the old city Chowk Bazar has been displaced by new commercial nodes and Civil Lines. These cities are, therefore, characterized by dualism. "The distinctive dual city form was difused over the country and developed its full range of distinct characteristics—the indigenous city and alongside".[6]

The physical landscape over which the city exists, its shape and size distortion also affect adversely the uniform spatial distribution of population. The growth of cities, thus, does not occur uniformly, instead, asymmetry, elongation and crenulation are the most common forms. Berry[7] also observed that with the distortion of shape, the density gradient diminishes. The complexity of shape and size is chiefly caused by physical attributes, i.e., rivers banks, lakes or some higher grounds form the site of cities. As in the case of the majority of Indian cities, the sites of almost all the cities in Bihar have been near some important river courses which have resulted in crenulation, elongation and ribbon shaped development. 'Nowhere the role of rivers has been so prominent in the evolution of towns as in northern India'.[8] Patna, for instance, flourished in a typical east-west linear fashion along the right bank of the Ganga because the adjacent lowland in the south was frequently liable to flood. Thus, a most intensive compact settlement was bound to grow on the limited available higher ground parallel to the Ganga. "The early traders and businessmen were attracted to have their establishments on the high and level ground on the southern levee of the river".[9] The growth of Gaya, Bhagalpur, Darbhanga and Muzaffarpur, likewise, has been encouraged both by the proximity to waterfront and limited available higher ground adjacent to the courses of the Phalgu, the Ganga, the little Baghmati and the Burhi Gandak respectively. In this way, the size and shape distortion of other cities in Bihar are largely controlled by physical factors.

Apart from the historical and physical reasons, there are some social forces like communal discrimination, caste system and social groupings which have a direct influence on the density patterns of Indian cities. The differences in socio-economic standards of population and their effects on human concentration are found at every level whatever the way of life.[10] Rigid caste system and consistently high level of communal discrimination have contributed towards significant segregation of people in compact areas resulting in emergence of secondary centres of population concentration within cities. In Indian cities, each civil ward is identified with certain definite cultural factors like castes, and sometimes even sub-castes. The social distance between the high caste and low caste people, Hindus, Muslims, Christians, etc., is maintained by denying residences to outsiders.[11]

Another important reason of very high central densities is that most of urban centres in India have grown from overgrown villages. In contrast to western countries where cities started developing almost on new sites, the majority urban centres in India are born out of rural markets, religious shrines, historical monuments, forts, etc. The original nucleus of modern Patna was Patligram (earlier Kusumpur), a simple village.[12] Muzaffar Khan, the founder of Muzaffarpur city was encouraged to lay the foundation of the city on the south bank of the Burhi Gandak comprising villages like Sikandarpur, Saidpur and Saraiyaganj, etc. The fort and fortress later accelerated the urban process and the city developed around them.[13] The present site of Bhagalpur city was once occupied by an almost uninhabited forest rather than a town. Champanagar and Nathnagar, the two large contiguous settlements on the west and south of the old Karngarh fort respectively, formed the portion of the city.[14] In Monghyr also, the early township started growing in a compact area to the east of the fort. The earliest nucleus of present Ranchi, was a small hamlet, the *Purana* Ranchi situated at a foot of the Ranchi Hill.[15] Hoselitz while attempting to trace out the salient features of urbanisation in India, has also stressed the village-like character of many neighbourhoods of Indian cities.[16]

At the initial sites of all these cities, compactness of settlement with irregular and haphazard street and housing patterns resulted because of the desire of all the inhabitants to be within the fortifications. It can be added that these defensive attributes further increased the compactness of the various establishments of the city and as a result, residential zones got intermingled with the business, industrial and the administrative areas which tied with each other for the safest desirable space.

In modern times, cities are rapidly expanding in size and new residential neighbourhoods are springing up at the city margin because of acute paucity of housing within the cities. The increased use of bicycles and public transportation has diffused the residential suburbs over a larger areas. This process of urban sprawl has an important bearing on

spatial population patterns and density gradients. It may also be noted that unlike western countries, city suburbs in India are not characterized by elite and people of affluent society, but there is a good combination of all classes of people. However, a good sprinkling of slums is found all over as a result of incorporation of villages (rural enclaves) and industrial units. Economically speaking, the wealthy continue to be in the central city. The middle class occupies the inner ring and the poor occupy the outer zone and have to use public transportation or use bicycles to reach the workplace.[17] In Japan also, Ginsburg[18] observed that suburban sprawl is more due to railways than highways and is occupied by poorer people with low level of housing condition. This is in direct contrast to Burgess concentric zonal hypothesis where the poor reside in the central city.

The above account of ecological forces operating through time reveal the fact that there is a great disparity in intra-urban spatial structure of urban phenomena. The entire processes involved in urban sprawl and population distribution is illustrated through a schematic diagram (Fig. 5.1) which reveals that the pre-historic and historic fort cities like those of the European walled cities were having colossal intensive agglomerated settlements around them with very thick population density (due to greater assurance of security). Until the commencement of British imperialism in India, security was the most powerful consideration in the growth and expansion of urban settlement. Thus, colonial[19] cities under the influence of Western culture and tradition were bound to gain momentum in urban sprawl as the existing indigenous tracts were not congenial for the British rulers. As a result of this, a new site of concentration of population and economic activities developed at a little distance away from the old city chowk and the area around it flourished enormously. Transportation as a factor for urban expansion was not recognized until the incorporation of municipal bodies in the later half of the 19th century. The impact of transportation on diffusion of residential areas, in true sense of term, was visualised with the introduction of public transportation and bicycles in the post-independence period which resulted in the emergence of residential neighbourhoods at the city suburbs. The schematic diagram given here reveals clearly the different phases of growth and sprawl of cities.

The aforesaid analysis makes it apparent that there are complex physical, socio-economic and cultural attributes responsible for a wide variation of population in urban areas. To make a scientific enquiry of the fact, geographers attempt to arrive at valid generalisations about a set of of facts concerning the spatial distribution of urban phenomena. While doing so, they formulate hypotheses about areal associations which may exist between the population phenomenon under investigation and

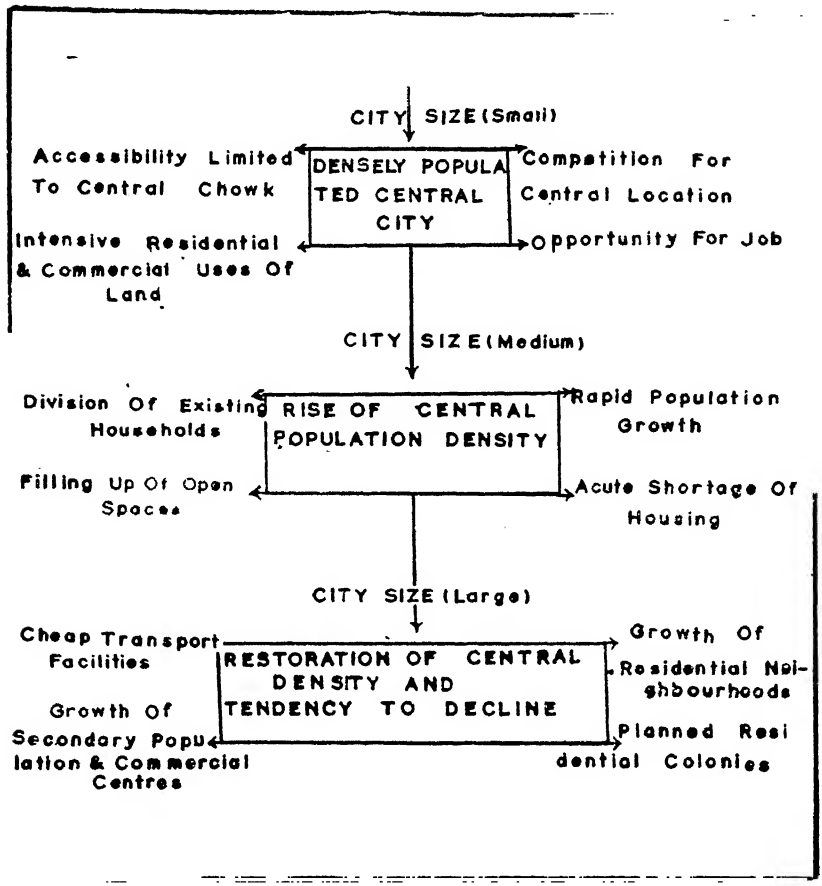

FIG. 5.1 : *Schematic Diagram of Intra-City Population Structure*

other factors. These hypotheses are based upon a set of observations or facts.

The formulation of hypotheses about spatial variation may be attempted in the context of some previous studies. Geographers and other social scientists have used many different approaches in attempting to explain the spatial aspects of components of population. They have attempted to identify characteristics of areas which have attracted population and to contrast these with the characteristics of areas which have either declined or remained relatively stable. Among these scientists we may note the views of Duncan and Reiss,[20] Zipf[21], Kariel[22] and Ullman.[23] They have adopted a statistically more sophisticated approach to the study of the distribution of geographical phenomena. Statistical

analyses were carried out in order to determine the amount of variation in the dependent variable under study which could be explained by selected independent variables. Studies of this nature have been attempted by Lee,[24] Bogue and Harris,[25] Thomas[26] and Yeats.[27]

For the purpose of present analysis, five factors have been selected for study as independent variables or determinants of differences in population density patterns. These are (i) Commercial area, (ii) Accessibility to means of communication, (iii) Urban Function, (iv) Proportion of Scheduled Castes and Scheduled Tribes and (v) Literacy. Data for the first two variables were calculated by the author with the help of the existing land use maps, road maps and field surveys. While others are based on District Census Hand books, 1971. The commercial areas and accessibility (in terms of length of roads per acre) were computed for each successive zone from the city centre in order to examine their association with population distribution. In order to show the spatial variation of other variables and their relation with population distribution, the average of absolute percentage values for all census tracts falling in successive zones from the city centre have been calculated.

Brief description of the impact of these variables on density variations is essential before detailed statistical analysis is taken up. In precise, population density is regarded as the dependent variable and the problem is to find out how the dependent variable is related to the above five independent variables. It is hypothesized that each of these factors has attracted population and is, thus, areally associated with population distribution.

Commercial Area

It is widely accepted that commercial area in a city is the focus of population concentration. In previous studies, little relationship has been established between density of population and any variable involving commercial attributes. In the present study, therefore, the extent and magnitude of commercial expansion has been considered. It was hypothesized that parts of the city having greater amount of commercial areas would experience relatively heavier concentration of population.[28] In contrast to Western cities where the principal commercial areas are almost devoid of residential population, Indian cities have usually mixed commercial and residential land uses. These cities have, very often, *bazar* kind of central business area in which residential apartments are commonly given to commercial purposes. Within the city, commercial activities start growing at the principal chowk and gradually spread in narrow streets and lanes—the process is followed by thinning out of residential areas and thereby intensifying both residential and commercial uses of land. In Western countries, planning being the basic consideration

for origin and development of city, there are clearcut and separate commercial residential, industrial and other functional units. Until recently, cities in India suffered from a complete absence of planning and the functional units could grow in most haphazard fashion. The commercial and residential areas are, therefore, inseparable. Even the dominant commercial areas are occupying the oldest part of the city, usually associated with the place of origin. On the outer edges of the CBD, the high density residential areas develop and are converted into slums and blighted areas consequent upon the maximum congestion and over-crowding of houses and people.[29]

Accessibility

Accessibility to means of transportation plays an effective role in the integration of all human activities. It appears reasonable to believe that because people wish to settle at the place of convenience from every point of view, they will tend to cluster towards areas where there is maximum accessibility. It was hypothesized, therefore, that those areas where accessibility to means of communication was the highest, would be thickly settled with relatively high population density. Accessibility pattern within a city is a reflection of the whole series of individual's decisions of the distances and the difficulty of travel between certain key locations such as work place, home, schools and shops. In Indian cities, accessibility to means of communication is negatively related to distances from the city centre but has considerable positive relation to residential land uses. People often have to move out from their home to work place, shops, recreation centre, etc., and they would like to select the easiest route. If transportation is supposed to be instantaneous and costless, then the people could have spread out over all usable urban space and land prices would be reduced. But transportation is not instantaneous and costless and modern social life requires concentration of population at places of convenience from every point of view.

Of course, for different activities the most accessible site varies but it is usually one at where movement costs are at a minimum. Other functions for which the accessibility requirements are different will find other sites. Both in the past and at the present, question of cost effectiveness have been major considerations. In modern times, though the expansion of the city following the increased transport facility and planned development has diffused the character of residential segregations, the overall patterns are the same.[30]

Urban Function

The most fundamental reason for population concentration in urban areas is that towns and cities are centres of diverse functions and large scale

employment. But the question arises, how are the city dwellers spatially distributed over the urban space? Is there any association between the functional establishments and the working forces engaged therein? In under-developed countries like India because of costly and inadequate transport facilities, working forces in urban areas prefer to settle very close to their work place. It was further hypothesized, therefore, that the concentration of workers in certain employments is found in areas of their functional establishments. In other words, the density of workers engaged in trade and commerce is maximum around the central commercial area which diminishes sharply as one moves out from there. Sjoberg[31] and Weber[32] have rightly observed that a characteristic feature of the pre-industrial city was the close proximity of work place and residence. They often shared the same building and the connection between industrial and domestic life was an intimate one. This situation still prevails in Indian urban condition and evidences are adequate. Persons engaged in trade and commerce are found to have their residence in proximity to the central commercial area. Administrative workers, likewise, try to settle around their administrative offices. Maximum concentration of teaching scholars and students is in areas of educational institutions. Weavers and craftmen get greater privileges by having industries in their own homes. The time and travel cost that a man takes to cover a certain distance from his home to his work place and to the central shopping area is obviously a vital factor in determining the pattern of residential areas within a city. In Western cities, there has been a growth in recent years of street cars, electric railways, motor ways and fast coach services which have allowed people to live further away from the work place.[33]

Proportion of Scheduled Castes and Scheduled Tribes

The Scheduled Castes and Scheduled tribes constitute a considerable proportion of India's urban population (15.35%). This proportion in the State of Bihar is 10.66 per cent. These people are considered to be socio-economically weakest segments of the society. Members of these groups experience a wide range of discriminatory treatment and frequently are related to positions relatively low in the status structure of our society.[34] These minority groups people in urban areas are very often found to have settled in most under-developed localities. As a result of their low income and low standard of living, they prefer to reside in the old blighted residential areas in almost clustered form because of low residential value. Thus, it has been observed that areas having greater proportion of Scheduled Castes and Scheduled Tribes are characterized by relatively high population density. The validity of this hypothesis has been examined

from the census data available on ward basis which make it possible to assess the spatial variation of Scheduled Castes and Scheduled Tribes.

Literacy

Literacy has been taken as a measure for variation of population within cities, though it may not directly be a causal factor. It is evident that considerable illiteracy exists in urban India which varies significantly in different parts of the city. Observations show that areas having high literacy, were characterized by relatively low population. As a matter of fact, the elite class people occupy the best developed residential localities within cities. It was hypothesized, therefore, that those areas of the city having high amount of literacy are sparsely populated and those with low literacy are thickly populated. The validity of this assumption has been evaluated on the basis of census tracts data available.

Testing of Hypotheses by Means of Correlation and Regression Analysis

To propound a theoretical rationale about an estimate involves testing of a hypothesis. In order to use statistical tests of significance of the assumptions, certain conditions have to be met. First, the observations should be randomly drawn from innumerable possibilities. Second, the data should be drawn from a normally distributed universe. Though it is most unlikely that these conditions are fulfilled completely in real life situation, the more closely they are met, the more exact will be the test. Third, the variance of the dependent variable must be constant for all the values of the independent variables. Lastly, the values of the residuals must be independent of each other, i.e., they should be randomly arranged along the regression line.

The first condition, that of random selection is assumed to have been met in this study as the observations have been drawn randomly from a hypothetical universe of possibilities. As regards the second condition, the necessary normalising transformations were made for the data of some variables. An accurate test of normality has been examined by plotting the individual observations on probability paper in the way suggested by Hald[35] and Smith.[36] This is known as fractile diagram (Fig. 5.2). The observations are ranked in ascending order and cumulative percentages are worked out. If a set of data was found to depart considerably from distribution, it was quite possible to transform it into a normal state. Thus, some sets of data may approximate to normality after transformation. A logarithmetic transformation as suggested by Blemmers and Lindquist[37] may be followed when there are considerable amount of deviations from normality. The third condition means that if the same process of obtaining data is repeated at fixed distance interval, the shapes of all the frequency distribution would be identical. There would, however,

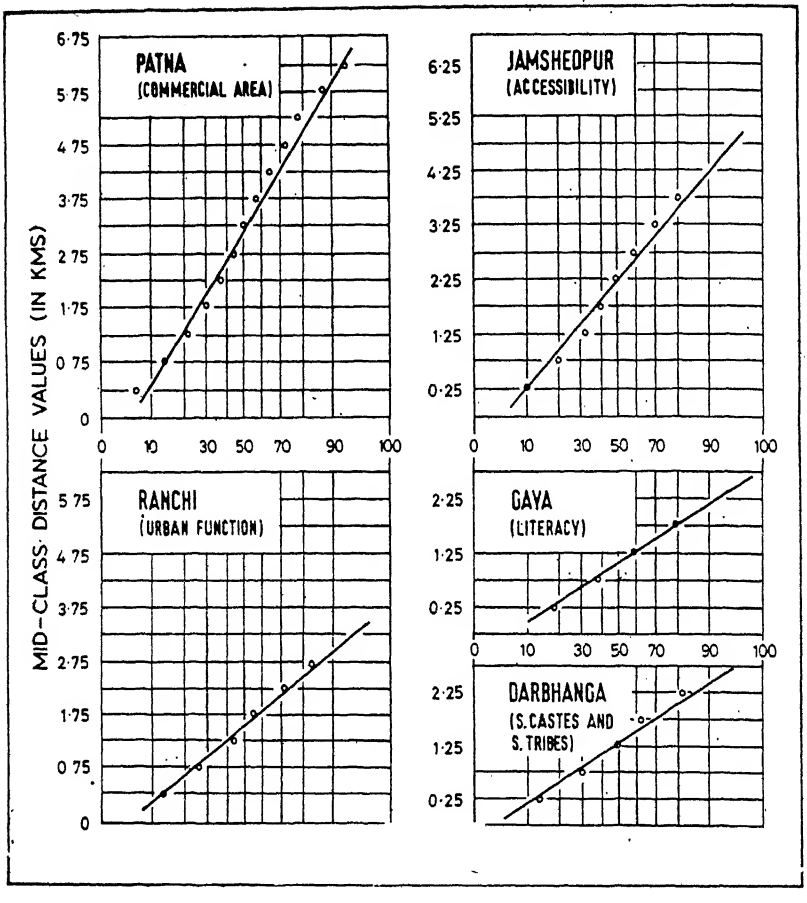

FIG. 5.2 : *Testing Grouped Data for Normality*

be a difference between the means of these frequency distributions. In fact, the least squares technique assumes that the means of all the distributions lie exactly along the regression line. The last assumption is also satisfied as there is no definite pattern in the residuals, i.e., they are all having the characteristics of a sequence of random numbers.

If the above assumptions are not fairly well satisfied, inferences made from a regression may be invalid, although the regression equation may still be of value in describing the relationship between two variables. Since these assumptions are often ignored in geographical applications of regression, it is worth emphasizing them by considering a hypothetical situation in which they are all satisfied. As linear correlation and regression analysis measure only the linear relationship between variables,

scatter diagrams were constructed in order to determine whether the relationship between the dependent variable and each independent variable was in fact linear. Inspection of these diagrams reveals no significant departures from linearity.

Results of Correlation and Regression Analysis

The analysis of data shows that the first three of the five hypotheses are strongly supported by the results of correlation regression analysis. That is, those areas of the cities which had greater amount of commercial areas, good accessibility to means of communication line and large number of concentrated functional establishments were characterized by heavier concentration of population. In contrast to this, the other two hypotheses are not confirmed by the analysis of data, i.e., the results are not in favour of the assumption that the areas of greater proportion of Scheduled Castes and Scheduled Tribes would correspond with areas of higher density, and areas with higher literacy would have lower population densities. The pro portion of Scheduled Castes and Scheduled Tribes, as a matter of fact, are negatively related to population density, i.e., population of these socially and economically backward communities increases with the increase in distance from the city centre, while population density declines with the increase in distance (Fig. 5.3). As such, people of these minority groups come in the lower strata of the society and they are forced to occupy the peripheral areas where they huddle together to create slums or increase sprawl. This is in direct contrast with Western cities where the poor occupy the central city and the wealthy live at the outskirt of the city.[38] Similar feature has also been observed by Schnore[39] who found that older urbanised areas tend strongly to possess peripheral population of higher socio-economic standing than the population of the central cities.

Literacy, on the other hand, is positively related to population density, i.e., the highest literacy exists in areas of highest population density. Singh also found high level of positive correlation of literacy (Fig. 5.4) and employment in trade and commerce in the densely inhabited core areas of the cities and a negative correlation with Scheduled Castes population, usually located on the urban periphery.[40] Both decline with the increase in distance from central city. In Western cities again, though illiteracy is almost non-existence, the elite occupy the fringe areas of the city. In India, the elite as well as the wealthy people are still occupying the central city.[41] The fringe area of the city, as a matter of fact, also includes a large number of rural enclaves (busties) where workers mostly derive their livelihood from primary occupation, and considerable illiteracy as in the countryside exists. Thus, the basic assumption that higher the literacy lower the density of population, is rejected and follows the principle of distance decay-function.

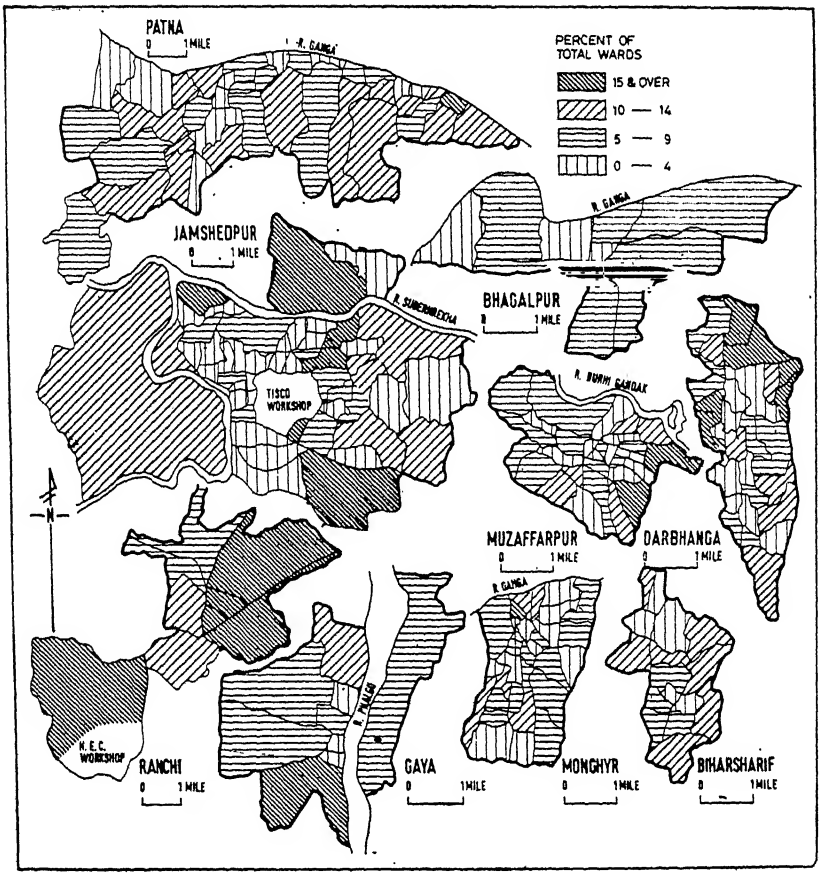

FIG. 5.3 : *Scheduled Castes and Scheduled Tribes*

The examination of correlation coefficients and coefficient of determination between dependent and independent variables unravel several significant points of their association. For all except one independent variable, however, the proportion of explained variation in the dependent variable as given by the coefficient of determination (r^2) was considerably high for all the cities in Bihar. The proportion of commercial area, accessibility to means of communication lines, urban function and literacy accounted for at least 20 per cent of the explained variation in the dependent variable of all the cities and in some cases, the explained variation reaches over 90 per cent. These determinants have, therefore, very strong bearing on the patterns of spatial distribution of population. The coefficient of determination or the per cent of variance in these indicators of population density ranges from 0.56 to 0.81 for Patna, 0.68

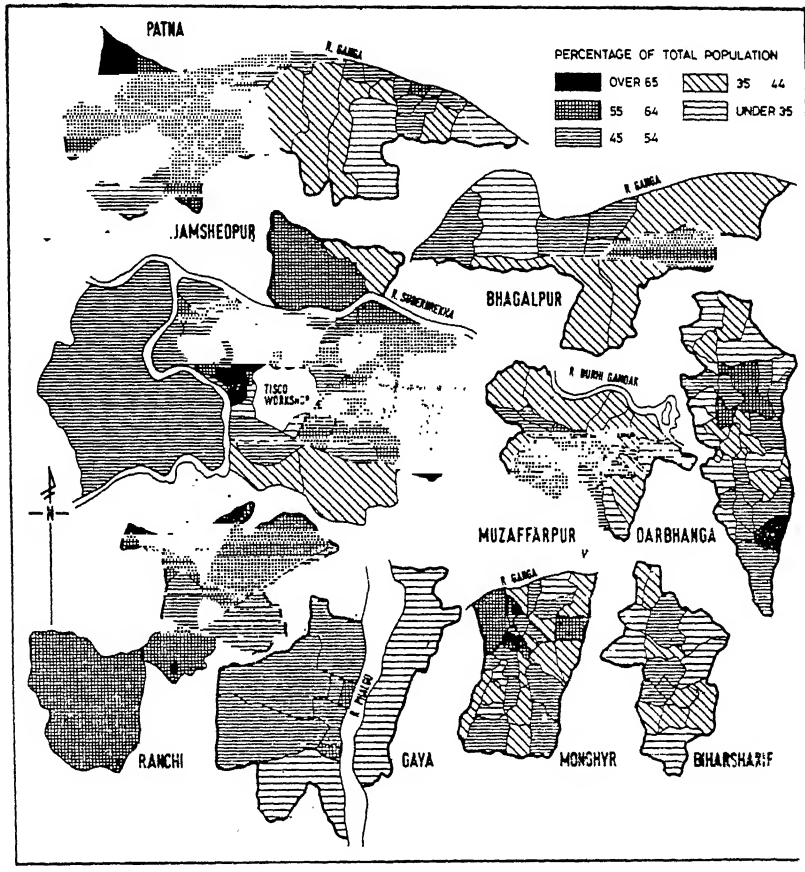

FIG. 5.4 : *Extent of Literacy*

to 0.84 for Jamshedpur, 0.19 to 0.90 for Ranchi, 0.81 to 0.98 for Bhagalpur, 0.81 to 0.98 for Gaya, 0.44 to 0.98 for Darbhanga, 0.90 to 0.95 for Muzaffarpur, 0.86 to 0.98 for Monghyr and 0.39 to 0.86 for Biharsharif. Thus, the association among these variables has some definite statistical significance, i.e., there is causal relationship between population density and variables selected.

The analysis of data for Patna gives a maximum coefficient of correlation of 0.90 and coefficient of determination of 0.81 for one independent variable, urban function which means that out of the three other important determinants, urban function has the closest association with population density. Accessibility to road and commercial area are the next important variables affecting the pattern of population distribution

TABLE 5.1 : **Coefficient of Correlation and Coefficient of Determination**

Cities	Variables (r values)					Variables (r^2 values)				
	1	2	3	4	5	1	2	3	4	5
Patna	.75	.76	.90	—.98	.59	.56	.58	.81	.97	.35
Jamshedpur	.88	.84	.83	—.92	.92	.78	.71	.68	.84	.84
Ranchi	.82	.95	.58	—.61	.44	.67	.90	.34	.37	.19
Gaya	.95	.98	.99	—.57	.90	.91	.97	.98	.32	.81
Bhagalpur	.97	.95	.93	—.85	.83	.95	.90	.87	.72	.68
Darbhanga	.99	.97	.77	—.64	.66	.98	.95	.59	.41	.45
Muzaffarpur	.96	.96	.97	—.98	.98	.92	.92	.96	.97	.96
Monghyr	.99	.94	.97	—.82	.93	.99	.88	.94	.69	.86
Biharsharif	.91	.63	.67	—.94	.93	.83	.39	.45	.89	.86

Variables : 1. Commercial Area,
2. Accessibility,
3. Urban Function,
4. Proportion of S. Castes and S. Tribes,
5. Literacy.

Source : Computation by the author.

with correlation coefficients 0.76, 0.74 and coefficient of determination 0.58 and 0.56 respectively. Literacy has the lowest coefficient value (0.59) which means that only 35 per cent of the variance of population density is explained by the regression. The proportion of Scheduled Castes and Scheduled Tribes has inverse association with population density. Very high degree of negative correlation coefficient (−0.98) indicates that there is a reverse causal relationship between the dependent and independent variables. When all determinants of population density are taken simultaneously to put them into a multiple correlation analysis, the result (R^2=0.98) shows that a little over 98 per cent of the variance in population density patterns is accounted for by these independent variables. This represents an increase of more than 8 per cent in the amount of variation accounted for in the simple correlation analysis, by the most closely related independent variable (Table 5.1).

The result for Jamshedpur reveals that the coefficients of correlation between population density and (independent variables) commercial area, accessibility, urban function and literacy are 0.88, 0.84, 0.83, and 0.92 respectively which show that there is very significant causal association among the set of variables selected for analysis. This indicates that the central wards with relatively higher population concentration are also characterized by the highest proportion of literate people. Literacy in Jamshedpur tends towards a central location adjacent to the TISCO

TABLE 5.2 : **Inter-Correlation Matrix***

PATNA

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.7476[1]	0.7646[1]	0.9011[1]	−0.9836[1]	0.5911[1]
X_1		—	0.4277	0.7250[1]	−0.6198[1]	0.6033
X_2			—	0.7994[1]	−0.5932[1]	0.2951
X_3				—	−0.6469[1]	0.2253
X_4					—	−0.9576[1]
X_5						—

R_y 12345=0.9988 R_y^2 12345=0.9870

JAMSHEDPUR

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.8819[1]	0.8407[1]	0.8282[1]	−0.9186[1]	0.9187[1]
X_1		—	0.6440[1]	0.8568[1]	−0.8844[1]	0.9624[1]
X_2			—	0.7676[1]	−0.8247[1]	0.7181[1]
X_3				—	−0.8518[1]	0.8809[1]
X_4					—	0.8330[1]
X_5						—

R_y 12345=0.9929 R_y^2 12345=0.9858

RANCHI

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.8794[1]	0.9471[1]	0.5857	−0.6085	0.4389
X_1		—	0.7959[1]	0.8045[1]	−0.5178	0.6399[1]
X_2			—	0.6155	−0.6629[1]	0.5855
X_3				—	−0.3760	0.8422[1]
X_4					—	−0.2520
X_5						—

R_y 12345=0.9997 R_y^2 12345=0.9940

TABLE 5.2—*Contd.*

GAYA

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9519[1]	0.9841[1]	0.9916[1]	−0.5692	0.9016[1]
X_1		—	0.9178[1]	0.9362[1]	−0.6273	0.9839[1]
X_2			—	0.9782[1]	−0.4329	0.8462[1]
X_3				—	−0.5205	0.8901[1]
X_4					—	−0.7073
X_5						—

R_y 12345=0.9998 R_y^2 12345=0.9960

BHAGALPUR

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9519[1]	0.9841[1]	0.9916[1]	−0.5692	0.9016[1]
X_1		—	0.9178[1]	0.9362[1]	−0.6273	0.9839[1]
X_2			—	0.9782[1]	−0.4329	0.8462[1]
X_3				—	−0.5205	0.8901[1]
X_4					—	−0.7073
X_5						—

R_y 12345=0.9989 R_y^2 12345=0.9970

DARBHANGA

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9746[1]	0.9474[1]	0.9354[1]	−0.8473[1]	0.8261[1]
X_1		—	0.9564[1]	0.8971[1]	−0.9641[1]	0.9214[1]
X_2			—	0.8235[1]	−0.9711[1]	0.8143[1]
X_3				—	−0.8390[1]	0.7868[1]
X_4					—	−0.9204[1]
X_5						—

R_y 12345=0.8859 R_y^2 12345=0.7849

MUZAFFARPUR

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9608[1]	0.9569[1]	0.9681[1]	−0.9857	0.9774[1]
X_1		—	0.9742[1]	0.9279[1]	−0.8115	0.9040[1]
X_2			—	0.9030[1]	−0.7603	0.8941[1]
X_3				—	−0.6569	0.9891[1]
X_4					—	−0.9768[1]
X_5						—

R_y 12345=0.9976 R_y^2 12345=0.9952

TABLE 5.2—*Contd.*

MONGHYR

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9941[1]	0.9394[1]	0.9680[1]	−0.8177	0.9281[1]
X_1		—	0.9214[1]	0.9614[1]	−0.7794	0.9055[1]
X_2			—	0.9618[1]	−0.6504	0.9939[1]
X_3				—	−0.9395[1]	0.9817[1]
X_4					—	−0.9585[1]
X_5						—

R_y 12345=0.9999 R_y^2 12345=0.9998

BIHARSHARIF

Variables	Y	X_1	X_2	X_3	X_4	X_5
Y	—	0.9112[1]	0.6282	0.6716	−0.9424[1]	0.9277[1]
X_1		—	0.4522	0.6846	−0.9703[1]	0.8892[1]
X_2			—	0.8496	−0.3231	0.7209
X_3				—	−0.5796	0.8707[1]
X_4					—	−0 8890[1]
X_5						—

R_y 12345=0.9916 R_y^2 12345=0.9833

*Detail Statistics of the above Variables are given in the Appendix.

1 Significant at 95 per cent confidence level

Dependent Variables : Y=Population Density;

Independent Variables : X_1=Commercial Area;
X_2=Accessibility;
X_3=Urban Function;
X_4=Proportion of S. Castes and S. Tribes;
X_5=Literacy.

workshop and on the east and north east of Sakchi shopping area. In the same way, high degree of statistical significance (at 95 per cent confidence level) for all variables means that commercial area, accessibility and urban function have some definite causal relationship with distribution of population. When all variables are taken together, a little over 98 per cent of the spatial variation in the dependent variable is accounted for (R_y^2=0.9858) by the multiple regression analysis.

Analysis of data for Ranchi, similarly, shows that accessibility to roads and commercial areas have greater attraction towards concentration of city dwellers in the central city than the other attributes. Their coefficient of correlation and coefficient of determination are 0.95, 0.90 and 0.82, 0.67 respectively, which indicate that over 67 per cent of the variance in the dependent variable is explained. Urban function and

literacy have relatively low coefficient values while the proportion of Scheduled Castes and Scheduled Tribes have strong negative correspondence with the distribution of population (−0.61).

In contrast to the above large size cities, the degree of association between dependent and independent variables are much stronger in small-sized cities. These cities, in spite of their long existence since historical time have been very much confined to small compact areas. Despite the acute scarcity of land and incongenial environment in the central city, residential and commercial areas are found to be very much centralised around the central chowk. The coefficient values of population density and its determinants for Gaya, Bhagalpur, Muzaffarpur and Monghyr range from 0.90 to 0.99 reflecting very high statistical association. In Darbhanga and Biharsharif also, two out of five selected variables, namely, commercial areas and communication networks have higher degree of correspondence with distribution of population and higher statistical significance (at 95 per cent confidence level). If all determinants are considered simultaneously, the result shows a little greater coefficient than those obtained by simple correlation analysis. The coefficient of determination or the per cent of variance in the dependent is a little over 99 per cent which means that these factors have most dominant impact on the residential and commercial segregation at the centre of these smaller cities.

The pattern of geographical variation in the above result can also be examined from Figures 5.5 and 5.6 which reveal the extent of closeness among a set of variables. The visual impression can also be verified by calculating the correlations between all six sets of scores taken in turn as pair. They are listed in the form of an inter-correlation matrix in Table 5.2.

The general impression from Table 5.2 is of fairly close correspondence between all except one of the five indicators and close agreement with the general population distribution. Even without speculating on possible causal relationship, some interesting observations can be made. In Patna, Jamshedpur and Ranchi, the commercial area as an indicator has a correlation of at least 0.43, 0.64 and 0.80 with other indicators. In smaller cities, this indicator has still higher coefficient values suggesting that all indicators selected for analysis of intra-urban variation of population are themselves significantly correlated with commercial area of the city. Similarly, accessibility to means of communication and urban function have intimate positive correspondence with other determinants which justify the fact that these parameters besides having profound causal relationships with population density patterns, are themselves closely associated. Literacy as a factor exhibits the lowest coefficient values with other

indicators in Patna, Jamshedpur and Ranchi while it has relatively closer relationship with other attributes in smaller cities.

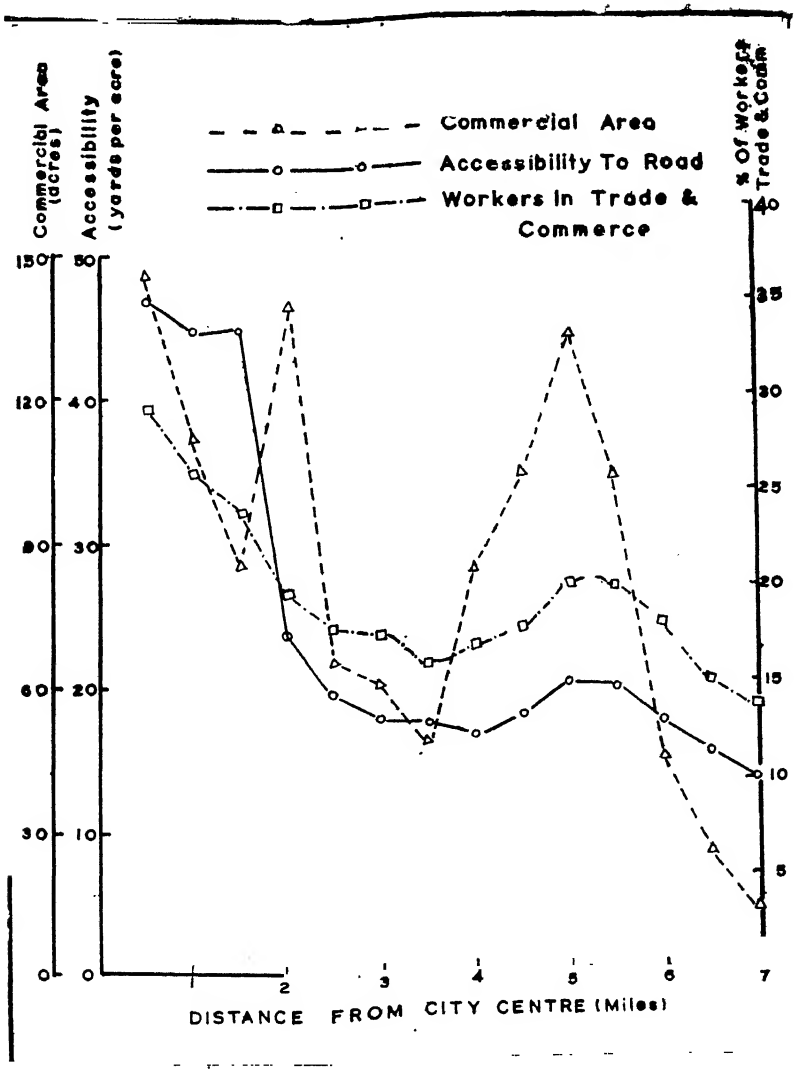

FIG. 5.5 : *Patna*

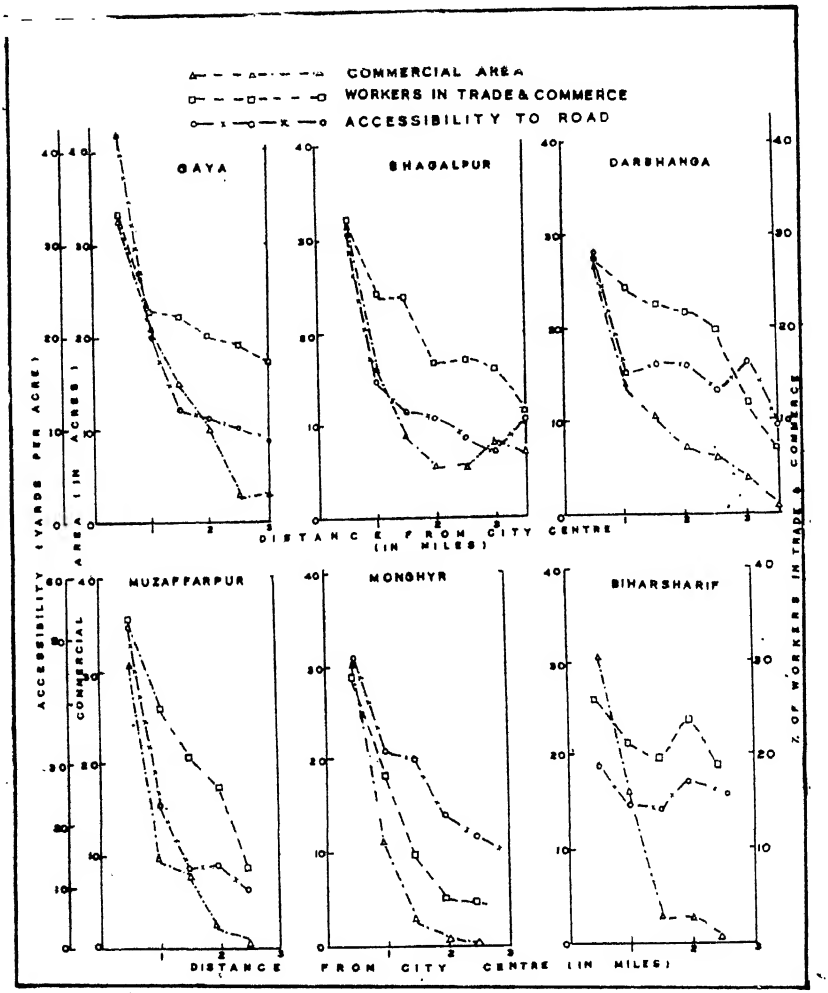

FIG. 5.6 : *Cities of Bihar (1971)*

Deviation from Regression

The deviant case analysis or the study of residuals from regression has been used in order to obtain clues in the attempt to achieve additional explanation of variation in the dependent variable. The coefficient of correlation and coefficient of determination are simply measures to show the degree of closeness between a set of variables. Similarly, a simple regression does not adequately reveal the observed population pattern. A line with several inflections as shown by the author is more significant than the straight line obtained by simple regression analysis. The standard method of measuring

the goodness of fit of a regression is to calculate the extent to which the regression accounts for the variation in the observed values of the dependent variables. Thus, the deviation from regression is defined operationally as the numerical difference between the observed values and the expected or computed values of the dependent variable for each area. In the present study the computed values for each city can be obtained by the use of the regression equation.

An examination of scatter diagrams reveals clearly the pattern of deviations from regression line. In Figure 5.7, the regression lines are drawn and individual observations are plotted in order to show the extent of closeness of the deviation along the regression line. It appears from the diagram that in the larger cities such as Patna, Jamshedpur and Ranchi because of defused character of commercial and residential areas, there is considerable deviation from regression lines. In Patna, the degree of deviation is found to be maximum outside the central commercial area because of dualism imposed by British administration. In the old Patna city and Muradpur commercial areas, the land is given to an intensive residential and commercial uses so that these areas are located above the regression line and even above the confidence limit. The extent of dispersion is considerable in the intermediate and transitional zones of the city because of spread of commercial areas in relatively sparsely populated census tracts. With continuous areal growth of the city, population is redistributed, and the central commercial area is no longer the focus of concentration of population.[42] "The commercial areas of a city are not fixed or permanent but keep on changing in their location, function and morphology in response to the changes in the size, population and structure of urban settlements. These changes include demographic shifts from one part of the city to another, changes in consumers income and transportation improvements."[43] These attributes of the city have been responsible for a considerable departure from the best fit line, though a little over 90 per cent of deviations are within the confidence interval (i.e., ± 29.17 from the regression line). The central zone with a mile radius from the commercial core of Muradpur and having about 22 per cent of the commercial land is the most densely populated part of Patna.

In the planned city of Jamshedpur, both residential and commercial areas are highly dispersed in nature and the general population density is very low as a result of the planning introduced by several planners and engineers. There is very high concentration of city dwellers in adjacent areas of the central commercial belt especially to the east of Sakchi and west and north-west of Bistupur (around the TISCO Main Workshop). There is, thus, a positive correspondence between commercial areas and distribution of population. The extent of deviation widens considerably in the outer zones of the city where some of the areas fall below standard error of estimate. This, in fact, justifies the ground that there is considerable

lack of sizeable commercial tracts in the newly planned residential colonies of Chhota Gobindpur, Baghbera and Adityapur, etc., at the fringe of Jamshedpur.

Similar to the other old cities, Ranchi is also characterized by a single predominant population centre in and around the principal commercial zone of the city. People are incredibly crowded in the most inner zone because of proximity to the shopping area and availability of maximum civic amenity services. There is, thus, an intimate association between commercial area and the distribution of population. The scatter diagram also confirms that because of most intensive commercial and residential uses of land, the area lies above the standard error of estimate but 95 per cent of residuals are within the confidence interval. Extent of deviation increases outwards specially in the areas of Jaganathnagar and Doranda due to planned residential and commercial development.

In contrast, the smallar cities show greater degree of association and greater statistical significance. The diagrams reveal that the patterns of deviation residuals along the regression line in the cities of Gaya, Bhagalpur, Darbhanga, Muzaffarpur, Monghyr and Biharsharif are more or less identical. In other words, the observations plotted along the regression lines are of a high order of linearity which justifies the validity of the assumption that those areas of the city having higher amount of commercial land would have heavier concentration of population.[44] In Gaya, the most densely populated areas are within a quarter mile distance from the central Sahibganj chowk. As a result of unusual centralisation of people and commercial activities, this area falls far above the confidence limit, while most of the observed values are arrayed very close to the regression line.

The pattern is still more apparent in Muzaffarpur and Monghyr which are also characterized by single predominant population and commercial centres. Both the density of population as well as the proportion of land given to commercial uses sharply decline outwards. In Muzaffarpur, the central city with a half mile radius from Saraiyaganj chowk has the maximum proportion of land given to commercial uses and most densely populated tract of the city. The degree of correspondence between these two variables can well be confirmed by the scatter diagrams (Fig. 5.7). Similarly, in Monghyr, the development of residential and commercial areas has been very much confined to a small but compact area to the east of the fort as a result of greater assurance of security granted by the rulers and a good accessibility. Both the attributes decline radically outward with the increase in distance from the centre. As characterized by binodal population centres, Bhagalpur and Biharsharif have very close conformity with commercial areas. The heaviest concentration of the city dwellers in Bhagalpur is around Suzaganj, which is also

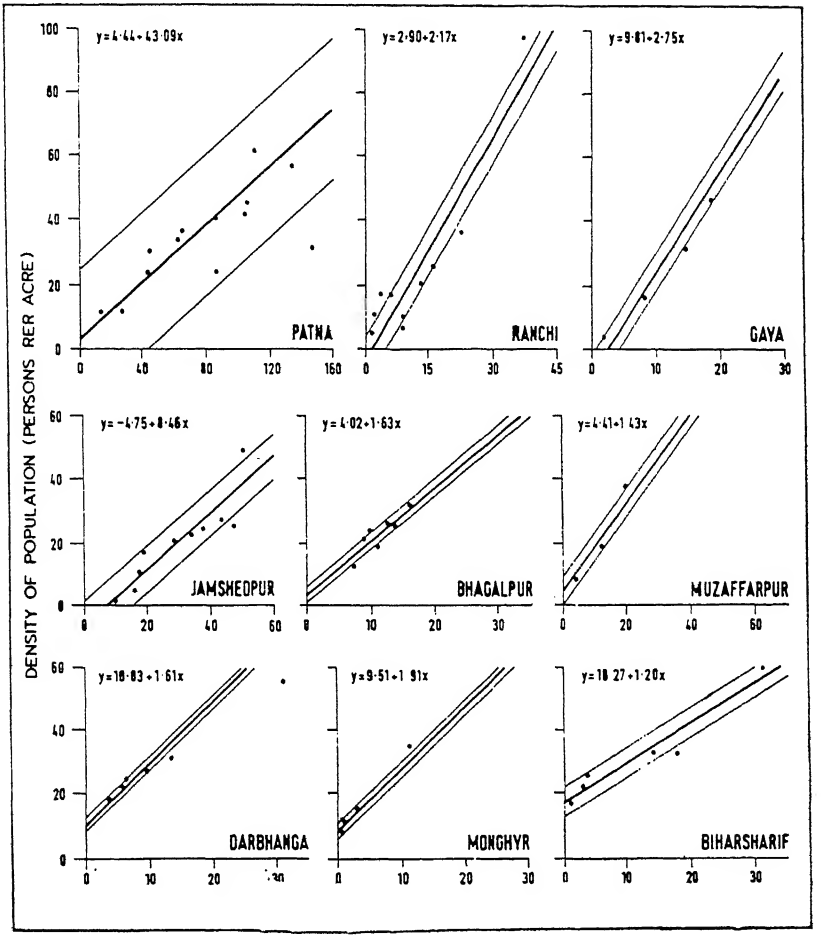

FIG. 5.7 : *Scatter Diagram—Commercial Area*

the principal commercial hub of the city and Nathnagar-Champanagar, the two contiguous settlements form a secondary population and commercial centre. Biharsharif also shows similar picture of association between these two independent variables. Secondary shopping centres arose at points of convergence of major transportation lines where they were convenient to a population of several thousands.[45]

Analysing the patterns of residuals from regression in the case of acccessibility to means of communication as a measure of distribution of population, some relevant features are traced out from the scatter diagrams (Fig. 5.8). Barring a few exceptions, the overall patterns are

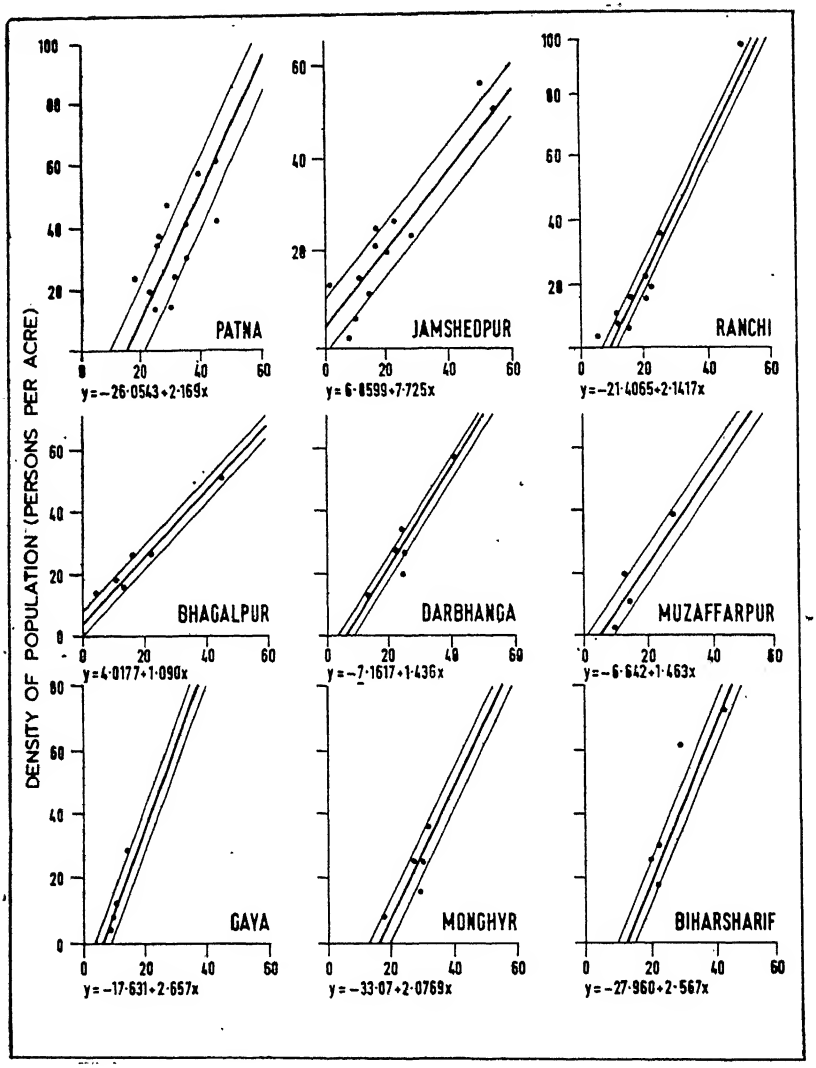

FIG. 5.8 : *Scatter Diagram—Accessibility*

the same, i.e., population distribution tends to concentrate in areas of good accessibility to transport routes. Within a city, accessibility is found to be maximum at the centre which diminishes sharply outwards with the increase of distance from the city centre. This high transport network primarily results from attractive forces exerted on residential population by the central business district. The nature of relationship between distribution of population and accessibility can be examined through

Figure 5.9 which confirm the impression of a positive relationship. In large-sized cities, the observed values when plotted along the regression lines make considerable departure from linearity and some of the extreme values lie above and below the confidence limit. In Patna, for instance, the central city with a relatively high accessibility (i.e., 47 ft. road per acre) is characterized by the heaviest concentration of population (i.e., over 200 persons per acre in some wards). But the density of road per acre is also high in the outer zones of Patna, especially in the planned residential colonies of Rajendranagar, Kankarbagh, Gardanibagh, Rajbansinagar, Patliputra and Srikrishnapuri, etc., with relatively low population densities. This attribute has been responsible for considerable degree of deviation from regression line in the marginal areas of the city. The patterns of association in Jamshedpur and Ranchi are almost similar to that in Patna though these cities have greater extent of correspondence than Patna. Accessibility in terms of length of road per acre is about 55 ft. in the innermost zone of Jamshedpur which is also an area of relatively high population density. Both the density of road and population per acre are reduced to one foot and 8 persons per acre in the suburban area. Likewise, the extent of association between distribution of population and accessibility to road per acre at the centre of Ranchi decreases as one moves outwards, but notable residual deviations are also marked in the outer zone because of the existence of planned residential areas with relatively low population per acre.

As regards the pattern of residuals from regression in other cities of Bihar, the scatter diagrams show closer degree of association and higher statistical significance. In these cities, transportation network is maximum around the central bazar which is the most crowded residential area. The extent of association bears a close resemblance between these two variables and the observed values, therefore, lie in proximity to the regression line.

Coming to the deviant case analysis of the two other variables, namely, urban function and literacy, they seem to have some definite bearing upon the intra-urban variation of population. The urban function is usually examined by employment data of different services. In the present analysis, the working force engaged in secondary functions especially those in trade and commerce have been taken into account. Labour forces employed in this function (Fig. 5.11) show positive correspondence with high concentration of people and commercial activities. "Accessibility to employment opportunities is positively related to residential land values. This relationship is sometimes swamped by the existence of satellite employment and shopping centres."[46] The density of workers in trade and commerce is similar to the trend of general density of workers and also the density of total population of the city.[47] The isopleth maps of workers in trade and commerce clearly reveal that high

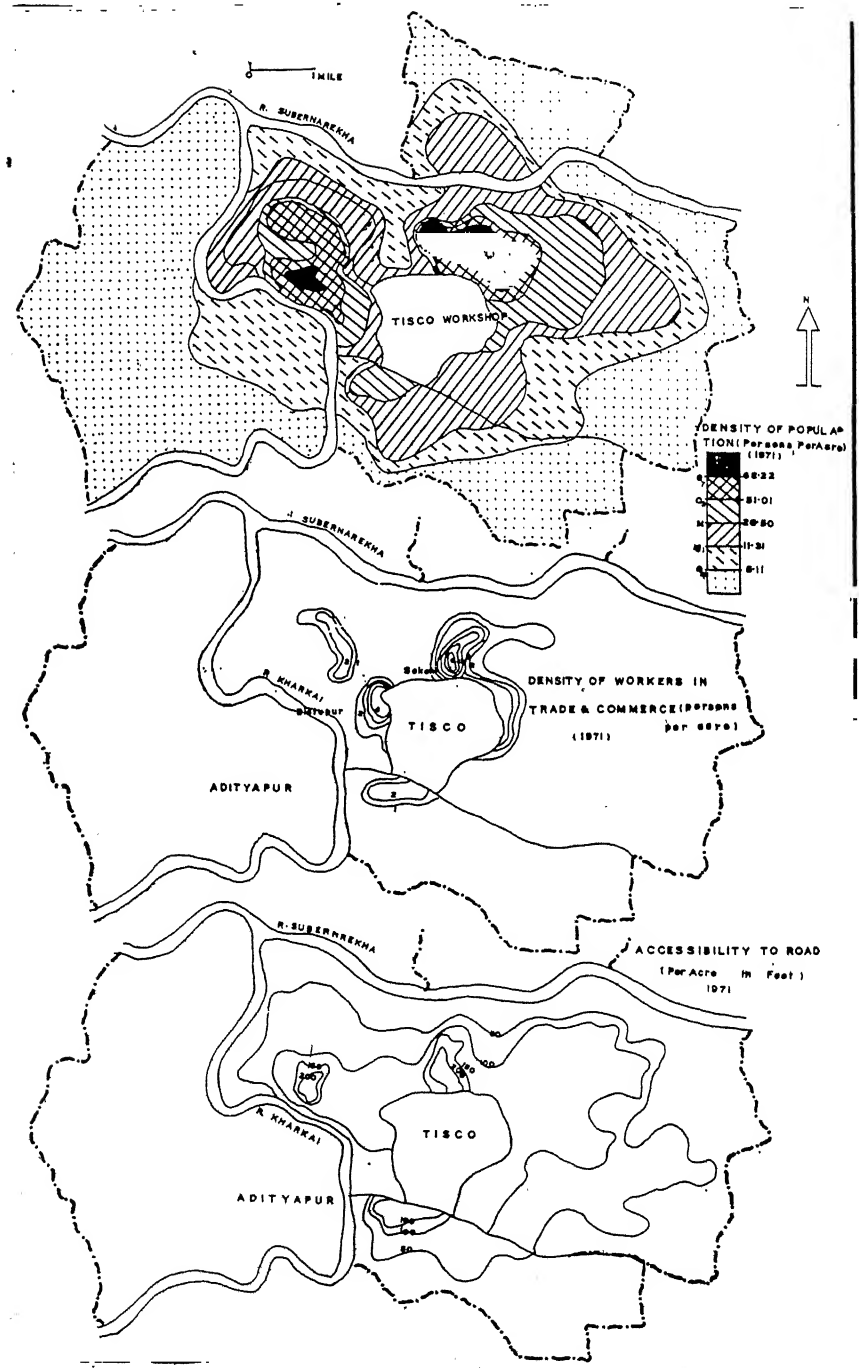

FIG. 5.9 : *Jamshedpur*

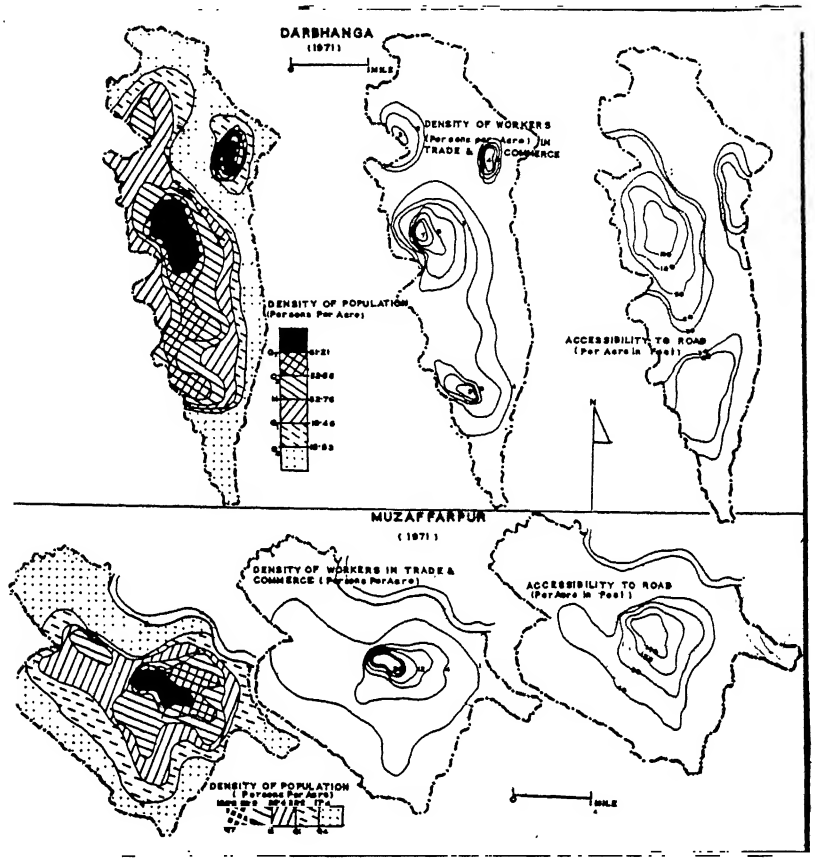

FIG. 5.10 : *Darbhanga and Muzaffarpur*

density zones are almost identical with the zones of general population density. The proportion of workers is maximum in the central zone and drops radically outwards (Appendix VI). Brush also observed that employment in this function shows the highest percentage in the river front ward, i.e., the densely populated city centre.[48] Thus, the conformance between population density and concentration of workers in trade and commerce bears a close resemblance and the observed values along the regression lines tend to occur with a high degree of linearity. Deviation of residuals from the estimating line occurs largely in large cities in which the introduction of public transport services has offered opportunities to people seeking residences in the suburbs. In smaller cities, the extent of deviations are minimised and about 95 per cent of residuals are within the confidence limit.

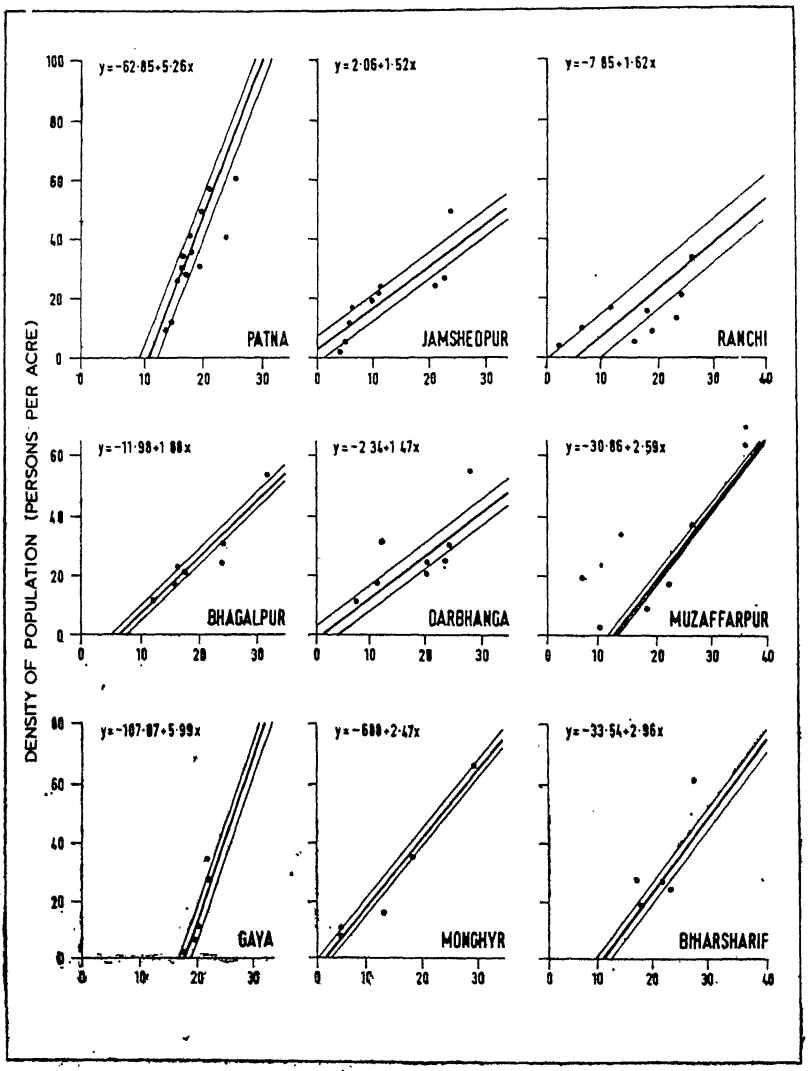

FIG. 5.11 : *Scatter Diagram, Commercial Workers*

As regards literacy as a determinant to population distribution, it was hypothesized that those areas of a city having high literacy would be sparsely populated and *vice-versa*. The analysis of data shows that the opposite is true, i.e., there is strong positive correspondence in all cities of Bihar. Literacy in central Patna is a little over 62 per cent. It gradually decreases outwards and is reduced to 35 per cent at the margin of the city. In Jamshedpur and Ranchi, the central cities have 64 per cent and

62 per cent of their population as literate. The figure declines with the increase in distance from the centre and are lowered to 50 and 51 per cent respectively at the periphery. In these cities some significant departure from conformity is chiefly accounted for by the redistribution of population due to areal expansion and emergence of planned residential areas at the outskirt of the city. The scatter diagrams (Fig. 5.12) for small cities reveal still closer association and higher statistical significance.

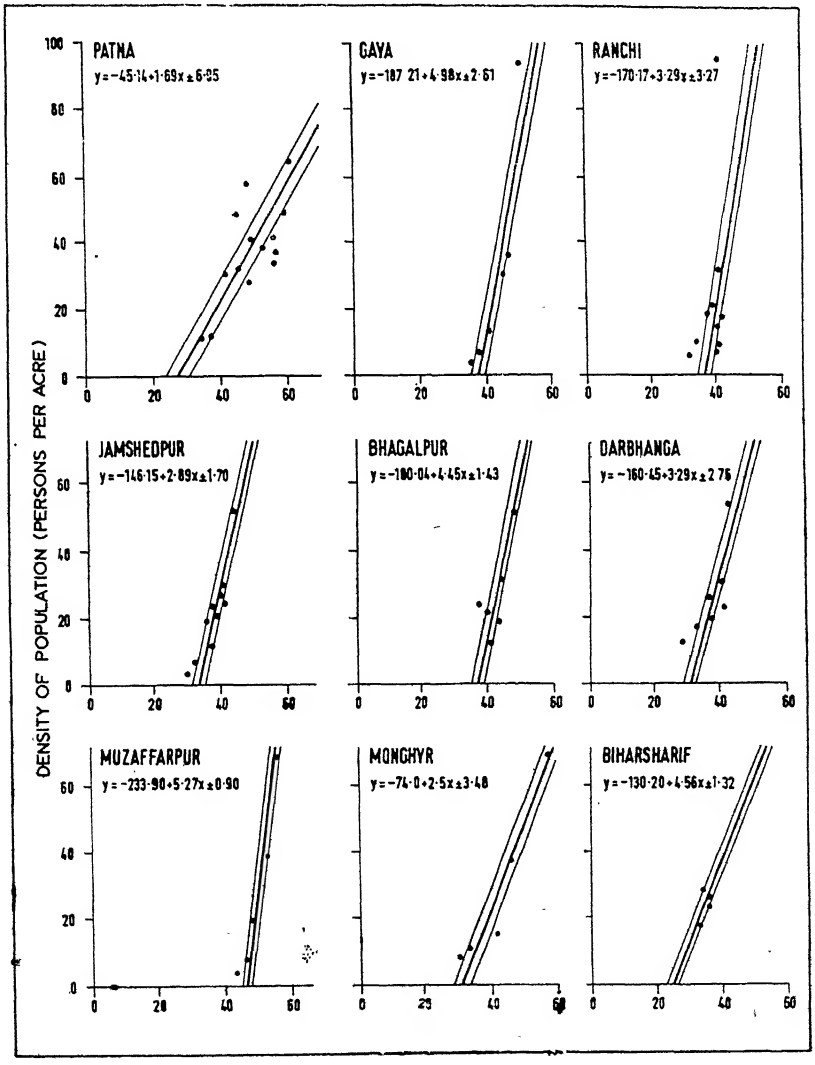

FIG. 5.12 : *Scatter Diagram, Literacy*

The Scheduled Castes and Scheduled Tribes, on the contrary, display a typical geographical pattern with the highest relative percentage in the periphery of the main city and in certain outlying areas which have low literacy rates.[49] This demographic attribute in urban areas, therefore, does not appear to be a causal determinant to the explanation of population variation within cities as it was hypothesized earlier. Analysis of data (Table 5.1) and scatter diagram (Fig. 5.13) for all the cities

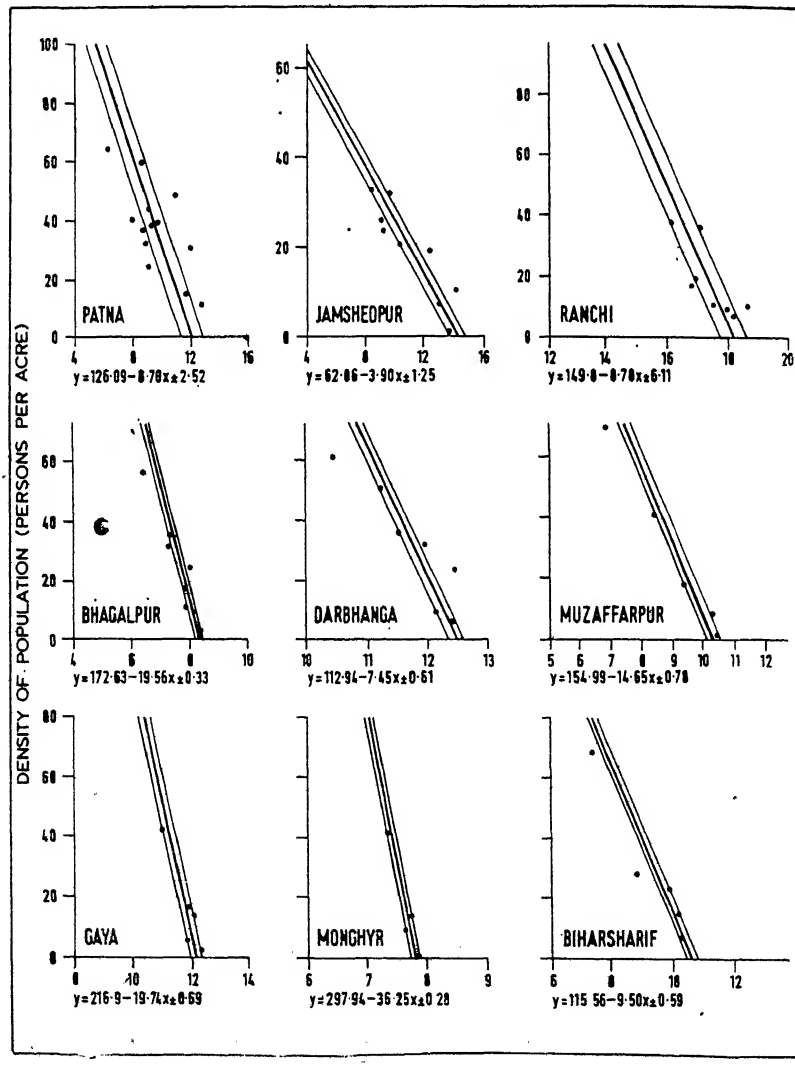

FIG. 5.13 : *Scatter Diagram, Scheduled Castes and Scheduled Tribes*

in Bihar confirm the validity of the assumption that there is inverse relationship between the distribution of population and these minority groups of people.

To conclude the account of the factors affecting patterns of population distribution, it is essential to highlight some of the basic points which appear to emerge from the above analysis.

Although the spatial variation of population within a city is the result of interaction of complex physical, socio-economic and cultural factors, it is possible to account for the major variations of the dependent variable by using a small number of independent variables.

Commercial area is one independent variable which has been found to make the greatest contribution to the explanation of spatial variation in the dependent variable. In both the simple and multiple correlation analyses, the commercial area has been found to be most closely associated with population density patterns. During the past few decades, some cities have rapidly increased in size and new residential neighbourhoods have come into existence at the margins of cities with the increased distance from the central shopping area. Under such conditions, a secondary commercial centre is bound to crop up in the new residential localities to meet the threshold supply of convenient goods. The extent of association in such cities is, therefore, relatively weaker than the cities characterized by single predominant population and commercial centres.

Next to the commercial area, accessibility to means of communication is another important independent variable for the explanation of spatial distribution of population. Residential areas within a city tend to grow at the most accessible sites and are, therefore, closely associated with transportation networks. Until recently, the city centre could enjoy the most accessible site from every point of view, residential, commercial (marketing), recreation, etc. It is, therefore, apparent that high accessibility at the centre has been responsible for incredible residential concentration. The other two variables, namely, the urban function and literacy have relatively low impact on the distribution of population.

Analysis of the patterns of residual deviations from regression makes it apparent that larger cities show relatively weaker association between dependent and independent variables than smaller cities. This, in turn, suggests that the large size cities are passing through the stage of rapid areal expansion and redistribution of population while the smaller cities are yet to undergo an intensive land utilisation phase and are still confined to small compact areas. As a matter of fact, suburban residential, commercial, industrial and other functions are emerging in larger cities in response to rapid growth of population.

If all independent variables are taken together, the degree of correlation is further enhanced which suggests that these variables besides their

individual influence on the distribution of population have also profound joint impact on it. Furthermore, all except one independent variable, namely, the proportion of Scheduled Castes and Scheduled Tribes, are themselves inter-correlated besides their causal relationships with population density patterns. Scheduled castes and Scheduled Tribes have inverse association with the general population density patterns, i.e., the proportion of these minority groups increases with the increase in distance from the city centre while the general population density declines outwards from the centre.

Finally, it may be noted that identification of the reasons for the predictive success of the independent variables is very complex, though a support of the concept has been found by testing of the hypotheses by statistical means. Until recently, commercial area and accessibility to communication lines have been the most powerful determinants of the extraordinary centralisation of population at the centre of the city. The influence of these factors is declining in modern times because of the areal expansion of the city concurrent with rapid growth of population and improvement in communication facilities. The result is, therefore, likely to be modified as soon as these cities after attaining a stage of intensive land use and population concentration, come to face outward expansion and redistribution of population.

REFERENCES

1. Referred by Guest, M.A., Urban Growth and Population Densities, Demography, Vol. 10, No. 1, 1973, pp. 53-68.
2. Richard, W. Redick, Demographic and Ecological Study of Rangoon, Burma in 'Contribution to Urban Sociology' (Ed. by Burgess, W.E. et al.), Chicago, 1953, pp. 31-41.
3. Berry, J.L. Brian and others, op. cit., pp. 395-96.
4. Davis, K., The Population of India and Pakistan, Princeton University Press, New York, 1951, p. 127.
5. Brush, E.J., Morphology of Indian Cities in India's Urban Future (Ed. by Roy and Turner), Bombay, 1962, p. 64.
6. Smailes, E.A., Indian City Structure in 'Urban Geography in Developing Countries' (Ed. by Singh, R.L.), N.G.S.I., Varanasi, 1973, p. 54.
7. *Ibid.*
8. Rizvi, S.Q.A., Role of Rivers in the Evolution of Urban Centres, Geographer, Vol. 9, No. 4, 1957, p. 45.
9. Dayal, P., op. cit , p. 12.
10. Garnier, J.B. et al., Urban Geography, Longman, London, 1967, p. 275.
11. Noel, P. Gist, The Ecology of Bangalore, India, An East-West Comparison, Social Forces, Vol. 35, 1957, pp. 356-63.
12. Master Plan for Patna, Patna Improvement Trust, 1962, p. 111-15.

13. Choudhary, P.C., Bihar District Gazetteers, Muzaffarpur, Secretariat Press, Patna, 1958, p. 232.
14. District Gazetteer, Monghyr, op. cit., p. 599.
15. Mukherjee, B., Ranchi: A Study in Urban Morphology, The National Geographical Journal of India, Vol. 2, Part-2, June 1956, p. 97.
16. Hoselitz, F. Bert, A Survey of the Literature on Urbanisation in India (Ed. Roy and Turner), India's Urban Future, Bombay, 1962, p. 424.
17. Mahadev, P.D., Intra-Urban Population Densities and Their Implications on Rural-Urban Eco-System in 'Urban System and Rural Development' (Ed. by Mishra, R.P., Part-I, Prasaranga, University of Mysore, Mysore, 1972, p. 167.
18. Ginsburg, N., Urban Geography and Non-Western Areas in Study of Urbanisation, (Ed. Hauser, P. and Schnore, L.), John Willey, 1965, pp. 311-46.
19. Raza Moonis and Habbes Atiya, Characteristics of Colonial 'Urbanisation—A Case Study of the Sattellitic 'Primacy' of Calcutta (1850-1921), in Urbanisation in Developing Countries' (Ed. by Alam, S.M. and Pokshishevsky, V.V.), Osmania University, 1976, pp. 185-219.
20. Duncan, D. Otis and Reiss, J. Albert, Social Characteristics of Urban Community, John Willey & Sons, New York, 1956.
21. Zipf George, The P_1, P_2/D Hypothesis on the Inter-city Movement of Persons, 'American Sociological Review', Vol. II, pp. 677-86.
22. Kariel, G. Herbert, Selected Factors Areally Associated with Population Growth Due to Net Migration; Annals of the Association of American Geographers, Vol. 53, 1963, pp. 210-23.
23. Ullman, L. Edward, "Amenities as a Factor in Regional Growth, The Geographical Review', Vol. 44, 1959, pp. 119-32.
24. Lee, S. Everett and others, Population Redistribution and Economic Growth, United States, The American Philosophical Society, Philadelphia, 1957.
25. Bougue, J. Donald and Harris, L. Dorothy, Comparative Population and Urban Research *via* Multiple Regression and Covariance Analysis, Studies in Population Distribution; Population Research and Training Centre, University of Chicago, Chicago, 1954.
26. Thomas, N. Edwin, "Areal Association Between Population Growth and Selected Factors in the Chicago Urbanized Area, Economic Geography, Vol. 36, pp. 158-70.
27. Yeats, H. Maurice, Some Factors Affecting the Spatial Distribution of Chicago Land Values, 1910-60, Economic Geography, Vol. 41, No. 1, 1965.
28. Taneja, K.L., Morphology of Indian Cities, National Geographical Society of India, Varanasi, 1965, p. 91.
29. Singh, H. and Dubey, K.K., Central Business Districts of 'Kaval' Towns in 'Readings in Urban Geography' (Ed. Singh, R.L.), The National Geographical Society of India, Varanasi, 1973, p. 245.
30. Everson, J.A. and Fitzgerald, B.P., Concepts in Geography: Inside the City, Longman, London, 1972, p. 159.
31. Sjoberg, G., The Pre-Industrial City, The Free Press, Glencoe, 1960, p. 161.
32. Weber, M., The City, D. Martindale and G. Neuwirth, Collins Book, New York, 1962, p. 81.
33. Wolforth, John, The Journey to Work, in Internal Structure of the City (Ed. Bourne, L.), Oxford University Press, Toronto, 1971, p. 241.
34. Prasad, R. and Ram, R.B., Scheduled Castes and Scheduled Tribes in Urban Set-up of Bihar (1961-71), Memeograph Service No. 58, Demographic Research Centre, Patna University, Patna, 1977.

35. Hald, A., Statistical Theory with Engineering Applications, John Willey & Sons, New York, 1952, p. 127.
36. Smith, M. David, Patterns in Human Geography, Penguin Books, Madison, 1975, pp. 98-103.
37. Blommers, P. and Lindquist, E.E., Elementary Statistical Methods, Haughton Mifflin Co., 1960.
38. Northam, M. Ray, Urban Geography, John Willey & Sons, INC, New York, 1975, p. 146.
39. Schnore, F. Lea, The Socio-Economic Status of Cities and Suburbs, American Sociological Review, Vol. 28, 1963, pp. 76-85.
40. Singh, Harbans, Patterns of Socio-Economic Structure in Indian Cities, Asian Profile, Vol. 3, No. 3, 1975, pp. 283-98.
41. Mahadev, B.D., op. cit., pp. 166-67.
42. Northam, M. Ray, Urban Geography, John Willey & Sons, New York, 1975, p. 220.
43. Dayal, P. and Thakur, B., Commercial Ribbons of Patna, National Geographical Journal of India, Vol. XXII, 1976, p. 165.
44. Rolph, K. Inez, The Population Pattern in Relation to Retail Buying; American Journal of Sociology, Vol. 38, 1932, pp. 368-76.
45. Proudfoot, J.M., City Retail Structure, Economic Geography, Vol. 13, 1937, pp. 425-28.
46. Brigham, F. Eugen, The Determinants of Residential Land Value: Land Economics, Vol. XLI, 1965, pp. 325-34.
47. Sami, A., Patna: Growth and Commercial Structure of Population; Indian Geographical Studies, Bulletin-4, 1975, p. 51.
48. Brush, E.J., Growth and Spatial Structure of Indian Cities in Indian Urbanisation and Planning (Ed. Noble, A.G. and Dutt, A.K.), Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977, p. 85.
49. Brush, E.J., op. cit., p. 86.

6

SUMMARY AND CONCLUSION

THE IMPORTANCE of study of large metropolitan communities has been abundantly recognised during recent decades as the cities are evidently the foci of modernisation and regional economic development. Besides, they are the centres of large scale employment, especially in secondary and tertiary services. Moreover, as towns of smaller dimensions exhibit many characteristics of rural areas, large urban communities may be taken as representative of the regional urban system.

The focal point in the present study of the cities of Bihar is in observing and trying to understand how growth of the cities occurs and what changes are brought about within them and in their immediate vicinity. In other words, our principal objective is to study these cities in terms of the number of people, the rate of increase and the internal patterns within them. While doing so, the aim has also been to examine theoretical viewpoints of other social scientists regarding the internal structure of cities.

In structure and relief, the State of Bihar comprises two distinct units—the plain area of the Middle Ganga valley in the north and the Chota Nagpur plateau of Peninsular India in the south. The former is characterised by deep alluvial soil and intensive subsistence farming while the latter abounds in rich mineral deposits, particularly coal and iron ore. The development of both hydel and thermal power has speeded up the progress of industrialisation. The growth of industry and transport and their natural outcome trade and commerce have provided the basis of growth of urban communities. But the majority of the cities in Bihar are of ancient origin and have flourished on the stable and defensive sites along river courses which also served as the principal arteries of communication during early periods.

The growth of cities and towns has largely occurred in the second half of the twentieth century while the older centres have experienced rapid

areal expansion and population concentration. The cities in early period developed as fortress because of defence needs. Besides, the cultural factors like religious shrines, fairs and markets, etc., were also operative in the siting of the cities. In medieval period, particularly during the Mughal period, the site shifting tendencies, development of handicrafts and trade, etc., became characteristic factors in siting and expansion of cities. In modern times, growth and sprawl has been largely accompanied by the development of transport, trade and industries.

A massive growth and expansion of cities occurred in the post-independence period with the improvement in agriculture and exploitation of minerals for industries. Out of 56.33 lakh urban dwellers in the State during 1971, 20.15 lakh or 35.78 per cent lived in class I cities and the remaining in small and medium-sized towns. In contrast, 52.41 per cent of India's urban population were found in 1971 in places of 100,000 or more. Thus, the role of cities in urbanisation process and patterns is very significant in India. In Bihar, such cities have largely emerged after 1931 and have been expanding steadily since then. The most phenomenal rise in the cities population was witnessed during 1931-41 with 192.58 per cent growth. The most important reason has been the raising of two medium-sized towns to the status of city during this decade. The subsequent decades (1951-61, 1961-71), likewise, experienced a significant rise in the cities population as a result of their numerical increase as well as the growth of population in the existing cities. Besides this, large scale immigration into urban areas took place due to the extraordinary pressure of population in agrarian sector and growth of employment opportunities especially in secondary and tertiary activities in urban areas.

While evaluating the inter-city and intra-city growth trends, it has been observed that the changes during early decades were somewhat more gentle than in recent times. Modern cities are changing fast in their growth, function and internal structure. Analysis of data has revealed that the industrial city of Jamshedpur appears to have surpassed other cities of Bihar during each and every census decade. The rapid population rise in this city is directly related to the expansion of the parent steel plant and the establishment of other ancillary industries. The pattern of growth in Ranchi since the beginning of this century has been regular and remarkable while other cities of the State have shown fluctuating trends. The most spectacular growth of Ranchi has taken place in the post-independence periods, as a result of massive growth of industries in the city suburbs and the decade 1961-71 witnessed the highest percentage (82.20%) increase. Other cities of the State, namely, Patna, Gaya, Bhagalpur, Darbhanga, Muzaffarpur, Monghyr and Biharsharif experienced widely variable trends simply because of their predominantly administrative functional character. Analysis of data further reveals that the relationship between the size of population of cities and their growth rates was extremely weak and it has

been found that some of the smaller cities recorded higher population increment than larger cities. The theoretical postulate that larger the cities, higher the growth rates, therefore, could not stand. These differential growth rates were solely responsible for deviation from the rank-size rule.

The patterns of intra-city population changes showed that transitional and peripheral wards of cities acquired more people than the central wards and in many cases the central cities even experienced decrease in population during 1961-71. Because of acute scarcity of residential land and incongenial surroundings in the crowded central city, people especially of higher income groups preferred to settle in the outer zones of the city. The spectacular rise of suburban population and the relative decline of the central city has been studied by several human ecologists who have arrived at divergent opinions with regard to the areal expansion and population redistribution. Population of these cities has been later estimated by different statistical methods in order to examine the expected pressure of future population on the limited urban space. It has been revealed that these cities after attaining a stage of an intensive land utilisation would undergo rapid urban sprawl and subsequently population would be redistributed.

The study's principal objective was, however, to investigate the patterns of intra-urban spatial distribution of population in the cities of Bihar based on the negative exponential model advanced by Western geographers and other social scientists. Very little work on this aspect has been carried out so far in developing countries.

An important feature of the present analysis of intra-city demographic aspects is the evaluation of the accuracy of data obtained because it determines the degree of reliance of the findings. While much of raw data has been taken from the census tables, the author on many occasions made successful attempts to confirm the data through field surveys. The crude data were processed in varying degrees to make a uniform assessment of intra-urban spatial variations of population attributes. The cities under study, were divided into different statistical zones at half a mile radius from the city centre and the magnitudes of selected variables for each successive zone were calculated in order to show their systematic areal variation. It is believed that barring a few avoidable errors in due course of data computation, the results are sufficiently accurate to justify the conclusion drawn from their analysis.

Critical evaluation of the methods applied is another significant feature of the present work. The important methods adopted here are linear (simple and multiple) regression analysis, rank correlation and Pearsonian Product Moment Correlation analyses which satisfactorily accounted for the variations in population density patterns in the cities of Bihar. These techniques were applied in order to evaluate the extent of causal association

between population density and selected independent parameters. They were useful for weighing the degree of correspondence between observed and expected population densities. In addition, the above techniques have been helpful in portraying the residual deviation patterns from regression which have been mapped to identify the isolated population islands. Apart from these, centrographic analysis, location quotient, etc., may have yielded some significant results with regard to spatial distribution of population. In the same way, population space relationship can also be established by drawing Lorenz Curves which can be helpful in evaluating the extent of unevenness of population distribution.

The major contribution here is, therefore, investigating the distributional patterns of population in the cities of Bihar, based on the results of correlation and regression analyses. While evaluating the results of regression analysis, it is useful to highlight some general features. People in urban areas are most unevenly distributed, i.e., at places there is incredible crowding while at some others, there are extremely low density zones. The central city with intensive residential and commercial uses of land is characterised by dense population which later diminishes outwards. There is, thus, some definite empirical regularity in population distribution at least in broad perspective. The central wards around the traditional *bazar* are heavily crowded with most complicated and haphazard residential development. The density curve at the core of the city, therefore, slopes sharply downwards which later tends to flatten at the margin. It is remarkable that the general density gradients when treated in terms of linear regression show higher correlation and higher statistical significance.

Analysis of data and scatter diagrams reveal that there are remarkable differences in the central density and density gradients between larger and smaller cities and also those characterized by single and binodal population centres. Moreover, larger cities had greater central densities than smaller ones, but the smaller cities had steeper density gradients than the larger cities. The study further revealed that the density-distance relationship in smaller cities registered higher correlation and higher statistical significance. Originated during the 17th and 18th centuries simply as rural markets, these urban communities could flourish in small compact areas discharging administrative functions. Thus, correlation coefficient in all cities except Patna, Jamshedpur and Bhagalpur were over 0.70 which meant very high statistical association between density and distance function.

The population density patterns differ markedly in cities characterized by binodal population centres from those observed above. In Patna, for example, the density profile slopes steadily within a mile distance from the centre and tends to flatten afterwards but rises again and then drops towards the periphery. As a result of the large variation of population densities, especially in intermediate and transitional zones, the central densities as computed by the estimating equation showed consistently

lower level in larger cities than in smaller cities. Since the last fifties, the larger cities have experienced rapid areal expansion and have become progressively less compact which has led to the flattening of the density curves. In Patna, apart from the principal population centre at Muradpur, the density is also very high at the older centre of Patna city chowk.

The density profile in Bhagalpur, likewise, tends to move downwards radically at Suzaganj but goes up at a distance of two and a half miles because of the existence of the old city centre around Karngarh fort (Champanagar). In Ranchi and Biharsharif, binodal profiles account for the emergence of industrial and commercial centres at the marginal areas respectively.

The planned city of Jamshedpur shows an entirely different pattern of population distribution. The city flourished in about 118.58 sq. km. largely in a planned fashion, designed by several planners and engineers who did not allow haphazard growth of residential over-crowding. The population density is, therefore, very low in general and in the central city in particular. The central city with a quarter mile radius from the centre reveals relatively low population density which increases afterwards and later abruptly slopes to the fringe of the city. The amount of vacant lands and open spaces are comparatively very large which explains the low population density per acre.

The extent of spatial variation of population within cities has been broadly examined by the study of deviation of residuals from regression. Wardwise, absolute population densities were plotted along the regression line according to distance increments from the city centre in order to examine the correspondence between observed and estimated population densities. It was found that the central wards having excessively high population per acre tended to cluster within a mile distance from the city centre and some of them were arrayed far above the confidence limit. The census tracts with extremely low density specially in outer zones fall below the line of standard error of estimate. Deviation of residuals were, thus, greater in the transitional and fringing wards than in the inner zones. The method of mapping the residuals also helped in bringing out the isolated peaks of population centres.

The highest population densities in Gaya exist in some of the river front wards, some of which are found to be above the standard error of estimate. Residential areas in these wards are characterized by crowded unhygienic buildings, often separated from one another by narrow, winding and dark lanes. Outside this central core, the density tends to decline rapidly with the distance increments. The geographical patterns of population space relationship in Darbhanga, Muzaffarpur and Monghyr reveal almost similar characteristics. The heart of these traditional cities exhibit areas of the highest population concentration comprising mixed but intense

commercial and residential uses of land. In these cities, residuals deviation are absolutely within the confidence interval which indicates that the lapse rate of population density has been regular and relatively constant with the increase of distance from the city centre.

The residuals deviation patterns in dual central cities are quite different from those in smaller and compact cities. The central commercial and residential wards are segregated along the regression line in the first mile while the degree of deviation widens outwards as a result of increased disparities in population distribution. In Patna, for instance, greater amount of deviations in outer zones account for the existence of indigenous tracts in Patna city as well as similar traditional *bazar* kind of commercial areas at Mithapur-Jakanpur. Because of very high population per acre, these areas are found above the standard error of estimate. Likewise, in Ranchi, Bhagalpur and Biharsharif, residuals are highly scattered in the fringe areas on account of the existence of sub-centres of population which may be explained as due to the impact of industrial and commercial growth in suburban areas. On the contrary, residuals deviation pattern in Jamshedpur reveals even more conspicuous features. To avoid the residential crowding and slum creation, the companies imposed strict measures on the centralisation of people. The residential areas were, therefore, kept highly dispersed. The residuals are, thus, almost uniformly arrayed along the regression line and lie largely within the confidence limit.

Explaining the relevant features of causal association of population variation, it has been found that numerous, physical, historical, socio-economic and cultural factors, operating since their origin, have been responsible for large disparities in distribution of population within cities. The history of evolution and process of growth are most fundamental elements contributing to unevenness of dwelling patterns. During historical periods, people, because of greater assurance of security, settled in adjacent areas of forts or nucleus of the city causing heavier centralisation of population at the centre. In British period, the English rulers brought about significant dualism in the character of growth patterns owing to their western culture and tradition. In addition to these, the physical characteristics of land over which the city existed had an adverse effect on uniform distribution of population in many cases. The site of the majority of cities in India has been river side oriented which resulted in elongation, crenulation and ribbon shaped developments. Apart from these, there were some social and cultural factors like communal discrimination, caste system and social groupings which contributed to clustered patterns and other significant discrepancies. As some rural markets, religious shrines, historical monuments formed the nucleus of growth of cities, these acted as centripetal forces in the concentration of people.

Because of non-availability of data on all the above attributes, it has

not been possible to make a scientific enquiry of the facts. In order to arrive at valid generalisations, the author has based his study on a few selected indicators affecting variations of population. Hypotheses based on observations were formulated about areal association which existed between the population distribution and factors selected for analysis. These were also examined with reference to some related previous studies of geographers and other social scientists. For statistical enquiry of the problem, the author has selected five indicators responsible for variations in density patterns. These variables are: Commercial area, accessibility to means of transport routes, urban function, proportion of Scheduled Castes and Scheduled Tribes and literacy. It has been discovered that the first three of the five variables are strongly associated with population density as supported by the results of correlation and regression analyses. In other words, areas of a city having greater proportion of commercial land, high accessibility and concentrated functional establishments are characterised by heavier concentration of population. Literacy has the weakest association while the proportion of Scheduled Castes and Scheduled Tribes has an inverse relationship with the distribution of population.

Evaluating the result of regression analysis, it has been revealed that the coefficient of correlation and coefficient of determination between the dependent and independent variables are remarkable. For all except one independent variable, the proportion of explained variation in the dependent variable is significantly very high in all the cities of Bihar. The determinants, namely, the commercial area, accessibility, urban function and literacy have, therefore, strong bearing on spatial distribution of population. Inspection of data has further revealed that the larger cities because of relatively wide disparity in spatial variation of population show low coefficients and lower levels of statistical significance. The coefficient of determination or the percentage of variance which range between 20 to 90 suggests that at least 20 per cent of the variation in the dependent variable is explained by the regression equation. When all determinants are considered simultaneously, the resultant coefficient values are still greater than those obtained from simple regression analysis which meant that the selected indicators made very significant contribution to the explanation of intra-urban variation of population.

In order to obtain additional explanation in the dependent variable and those which remained unexplained, residuals deviation patterns were broadly taken into account. Study of scatter diagrams reveals that the larger and dual centred cities of Patna, Jamshedpur, Bhagalpur and Biharsharif, because of vast areal extent and defused character of residential and commercial areas, exhibit greater residual deviations from regression, especially, in the outer zones. The pattern of deviations was almost identical in all the four parameters selected for analysis. In contrast to this, a linear

but symmetrical pattern of residuals was found in the smaller-sized cities of Gaya, Darbhanga, Muzaffarpur and Monghyr. These, evidently, suggest that the rate of decline of population density in these cities is somewhat systematic and regular. As a result of their confinement into small compact areas, these cities are characterised by unusual centralisation of people in their centre. The first three of the five variables, namely, commercial area, urban function and accessibility, therefore, make maximum contribution to the explanation of the heaviest concentration of residential dwellings in the innermost zones of these cities. Literacy accounts for the minimum while the proportion of Scheduled Castes and Scheduled Tribes has a reverse correspondence with the density of population.

As far as the author's approach in constructing a systematic theory, based on the above observations, is concerned, it may be stated that there are two popular concepts of intra-city structure developed so far—first, the concept of distance-decay and second, the concept of friction of space. The former illustrates that economic activities in urban areas tend to decline in direct proportion to the distance from the nucleus of the city (Negative Exponential Function), while the latter examines the growth and sprawl of cities as a result of rapid population increase and sharp competition for land within urban areas. Both the concepts have received due attention in modern times, particularly in the developed nations of the world. The present study of intra-city population structure largely tends to support the first concept, i.e., population space relationship follows the principle of negative exponential function. As is the case with many urban phenomena, like intensity of land use, land value, and house rent, etc., population densities decline with the increase of distance from the central commercial area.

The cities of Bihar are passing through an intermediate stage of their process of growth. During recent years, new residential colonies and other planned areas have started cropping up in the fringe zones of the city. In the inner zones, however, because of largely unplanned and haphazard developments, the problem of scarcity of space, abnormal residential crowding and blighted residential areas, etc , have become acute. Keeping in view of these problems, a few points are essentially needed to be highlighted for a healthy development of cities.

(i) Attempts should be made to check further increase of population density by providing disincentives to the immigrants to settle in the central city.

(ii) Satellite townships should be developed at the fringe of cities for immigrants and city dwellers.

(iii) The residents of central city should be encouraged to seek residential facilities in suburban areas by providing better transport facilities linking the suburbs with city centre.

(iv) Planned residential development in suburban areas may minimise the central population densities.

(v) Adequate measures should be taken to improve transportation facilities and provide easy and cheap access of residents to their places of work.

(vi) In order to meet the supply of convenient goods for the neighbours, creation of secondary commercial centres is also suggested.

(vii) The central functions like industry, commerce, administration and centre of higher learning, etc., should not be allowed to concentrate in large cities, as these are very much responsible for their massive sprawl and growth. Moreover, these functions should be kept highly decentralised on regional or sub-regional level.

Although the present work is merely a fragment of the study of components of population, its implication at the stage of modern rapid urbanisation deserves careful consideration. The conception of cities in terms of number of people and space has been a thorny problem before researchers which poses several questions regarding the causes of concentration and deconcentration of people. Thus, while pointing out the strategy for future research directions, it can be added that the present findings are based on the limited descriptive account and a few statistical measures which can further be enquired into by techniques suggested and many other sophisticated methods. Moreover, population density patterns in urban areas is the result of interactions of numerous physical, historical, social and economic factors and only a few of these have been taken into consideration. Further studies of some additional causes of varying population density patterns may help in arriving at more concrete conclusions.

Another important problem related to the current study, but which has not been the objective of this work, is to examine the temporal changes of population density patterns which may be taken up for future research. Problems related to the intra-city population structure such as suburban residential growth patterns and intra-city mobility patterns also need careful consideration. In modern times, almost all cities are experiencing rapid areal explosion and it is indeed essential to examine the growth trends and sprawl and their retrospective impact on the patterning of

residential neighbourhoods. The author has simply attempted to introduce this field of urban study of intra-city spatial structure of population in a developing country and it is hoped that scholars interested in urban planning will undertake projects to make a detail intensive study of the internal structure of the city.

APPENDIX I

Decennial Population of the Cities in Bihar (1901-1971)

Towns/cities	1901	1911	1921	1931	1941	1951	1961	1971
Patna	1,34,785	1,36,153	1,19,976	1,59,690	1,96,415	2,83,479	3,64,594	4,91,217
Jamshedpur	—	5,672	57,360	92,459	1,65,395	2,18,162	3,28,044	4,56,156
Ranchi	25,970	32,994	39,628	50,517	62,562	1,06,847	1,40,253	2,55,551
Gaya	71,288	49,921	67,562	88,005	1,05,223	1,33,700	1,51,105	1,79,884
Bhagalpur	75,760	74,349	68,878	83,847	93,254	1,14,530	1,43,850	1,72,202
Darbhanga	66,244	62,628	53,700	60,676	69,203	84,816	1,03,016	1,32,059
Muzaffarpur	45,617	43,668	32,755	43,049	54,139	73,594	1,09,048	1,26,379
Monghyr	35,880	46,913	46,825	52,863	63,150	74,348	89,768	1,02,474
Biharsharif	45,063	35,151	36,720	46,994	54,551	63,124	78,581	1,00,046
Total	5,00,607	4,81,449	5,20,404	6,84,100	8,63,892	11,52,700	15,08,259	20,15,958

Note: Population of Patna, Jamshedpur and Ranchi also includes the population of adjoining towns and townships forming town-groups/urban agglomerations.

Source: Data based on District Census Handbooks of Patna, Singhbhum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr, 1971.

APPENDIX II

Movement of Class I Towns or Cities in Cities of Bihar (1901-1971)

Cities	1901	1911	1921	1931	1941	1951	1961	1971
Patna	I	I	I	I	I	I	I	I
Jamshedpur	—	IV	II	II	I	I	I	I
Ranchi	II	III	II	II	I	I	I	I
Gaya	III	III	III	II	II	I	I	I
Bhagalpur	II	II	II	II	II	I	I	I
Darbhanga	II	II	II	II	II	II	I	I
Muzaffarpur	III	III	III	III	II	II	I	I
Monghyr	III	III	III	II	II	II	II	I
Biharsharif	III	III	III	III	II	II	II	I

Note : The Census autuority classified Indian towns into six categories, based on the size of population.

1. Class I towns or cities (100,000 or more population)
2. Class II towns (50,000—99,999)
3. Class III towns (20,000—49,999)
4. Class IV towns (10,000—19,999)
5. Class V towns (5,000— 9,999)
6. Class VI towns (Below 5,000 population)

Source : Based on the Census of India, 1961 and 1971.

APPENDIX III

Rural-Urban Population of Bihar (1901-1971)

(Figures in Parentheses are Decennial Growth Rates)

No. of Cities	1901	1911	1921	1931	1941	1951	1961	1971
	1	1	1	1	3	5	7	9
Population of Cities	1,34,785	1,36,153 (+1.01)	1,19,976 (−11.88)	1,59,690 (+33.10)	4,67,033 (+192.58)	8,86,718 (+89.86)	13,39,910 (+81.10)	20,15,958 (+50.45)
No. of Towns	57	59	63	66	84	113	153	202
Population of Towns	9,62,200	9,41,733 (−2.12)	10,45,949 (+11.06)	12,62,681 (+20.71)	14,34,069 (+23.57)	17,39,543 (+21.30)	25,74,010 (+47.98)	35,26,766 (+37.01)
Urban Population	10,96,985	10,77,886 (−1.92)	11,65,925 (+ 9.30)	14,22,371 (+22.00)	19,01,102 (+32.99)	26,26,261 (+37.07)	39,13,920 (+50.94)	56,33,966 (+43.94)
Rural Population	2,62,14,880	2,72,36,395 (+3.90)	2,69,60,750 (−1.04)	2,99,24,737 (+10.99)	3,32,69,738 (+11.21)	3,61,56,010 (+8.75)	4,25,33,537 (+17.54)	5,07,19,403 (+19.24)
Total Population	2,73,11,865	2,83,14,281 (+3.67)	2,81,26 675 (−0.66)	3,13,47,108 (+11.45)	3,51,70,840 (+12.20)	3,87,82,271 (+10.27)	4,64,47,457 (+19.77)	5,63,53,369 (+21.32)

Source : Data are based on the Census of India (Bihar), General Population Tables, 1961 and 1971.

APPENDIX IV

Methods Adopted for Analysis of Future Estimate of Population in the Cities of Bihar

1. *Least Square Method*

The least square method to estimate future population involves the following equation :

$$y=a+bx+cx^2$$

where y is the total estimated population of cities.
x is the census decade.

a, b and c are the three (parameters) unknown quantities which have to be found out. Thus, the data having two variables, *e.g.*, population (y) and census year (x) are treated in terms of second degree of parabolic equation :

$$y=a+bx+cx^2$$
$$y=na+bx+cx^2$$
$$xy=ax+bx^2+cx^3$$
$$x^2y=ax^2+bx^3+cx^4$$

After putting the values, the normal equation will be :

$$4973368=6a-3b+19c \quad \text{(i)}$$
$$4193651=-3a+19b+27c \quad \text{(ii)}$$
$$11525651=19a-27b+115c \quad \text{(iii)}$$

These three equations have been solved simultaneously to get the values of constants a, b and c.

$$a=844260.653$$
$$b=447545.930$$
$$c=65812.730$$

or, by putting values of constants, the result comes

$$y=844260.653+447545.930x+65812.730x^2$$

The estimated population for 1981=27,13,400.283.

Estimates for 1991 and 2001 have been similarly calculated.

2. *Arithmetic Progression*

Population of 1971=20,15,958
Population of 1921=1,19,976
Growth in 50 years=18,95,982, i.e., 37,920 persons per year.
Estimated population in 1981=1,19,976+(60×37,920)=23,95,116

3. *Geometric Progression*

Formula : $y=ar^{n-1}$

where y, is the year chosen,
a, is the base year,
r, is the common factor,
n, is the interval of years.
and

Population 1921 = 1,19,976
1971 = 20,15,958 (in 51 years from 1921)

Thus, $20,15,958=1,19,976\times r^{51-1}$

or $r^{50}=\frac{20,15,958}{1,19,976}$

or $\log r = 1/50\ (\log 20,15,958 - \log 1,19,976)$
$= 1/50\ (6.3044815 - 5.0790945)$
$= 1/50\ (1.2253870)$
$= 0.0245077$

Now population in $1981 = 1,19,976\times r^{61-1}$
log population $1981 = \log 1,19,976 + 60 \log r$
$= 5.0781003 + (60\times 0.0245077)$
$= 5.0781003 + 1.4704620$
$= 6.5485623$

Therefore, population in 1981 = 35,36,409

Estimates for 1991 and 2001 have been similarly calculated.

APPENDIX V

Intra-city Population Variation (1961-71)

Wards	Population 1961	Population 1971	Decade variation	Percentage decade variation
1	2	3	4	5
		Patna		
1	7,516	15,099	+ 7,583	100.85
2	16,240	10,776	− 5,474	−33.70
3	11,983	18,665	+ 6,682	55.76
4	6,327	22,599	+16,272	257.18
5	9,200	8,465	− 735	− 7.98
6	11,279	7,730	− 3,549	−31.46
7	6,440	11,691	+ 5,251	81.53
8	10,796	16,931	+ 6,245	57.84
9	9,120	10,226	+ 1,106	12.12
10	5,837	11,840	+ 6.003	102.84
11	12,912	17,634	+ 4,822	37.63
12	10,189	13,702	+ 3,513	34.47
13	13,029	13,510	+ 481	3.69
14	11,967	23,090	+ 1,123	9.38
15	8,532	12,096	+ 3,564	41.77
16	8,514	12,457	+ 3,943	46.31
17	8,921	16,081	+ 7,160	80.26
18	8,072	15,957	+ 7,885	97.68
19	10,100	10,550	+ 450	4.45
20	5,820	10,558	+ 4,738	81.80
21	8,667	13,693	+ 5,026	57.99
22	11,112	10,340	− 782	− 7.03
23	8,078	11,298	+ 3,220	39.46
24	7,954	12,302	+ 4,244	54.79
25	8,077	12,321	+ 4,936	52.54
26	8,883	13,819	+ 4,650	55.56
27	6,082	10,732	+ 3,039	76.96
28	8,801	11,840	+ 2,988	34.53
29	7,791	10,679	+ 2,854	38.35
30	7,420	10,274	+ 2,854	38.46
31	6,727	12,471	+ 5,744	85.38
32	7,140	9,723	+ 2,583	36.67
33	16,140	9,076	− 7,064	43.76
34	12,040	10,911	− 1,129	− 9.37
35	11,259	10,205	− 1,054	− 9.36
36	11,792	13,701	+ 1,909	16.18
37	23,033	9,969	−13,064	−56.71
Patliputra Colony	894	2,299	+ 1,405	157.15
Total	3,64,594	4,75,300	+1,10,706	30.37

(Contd.)

APPENDIX V (*Contd.*)

1	2	3	4	5
		Ranchi		
1	16,227	21,460	+ 5,233	32 34
2	22,025	26,082	+ 4,057	18.41
3	19,277	31,079	+13,802	71.59
4	15,471	21,201	+ 5,730	35.03
5	10,536	11,791	+ 1,255	11.91
6	15,968	26,413	+10,445	65.41
7	22,912	37,908	+14,996	65.45
Doranda	17,837	23,954	+ 6,117	34.29
Jaganathnagar	20,000	55,663	+35,663	+178.35
Total	1,40,253	2,55,551	+1,15,294	72.20
		Gaya		
1	24,435	36,408	+11,973	49.00
2	9,301	9,497	+ 196	2.10
3	15,918	15,159	− 759	− 4.75
4	36,910	45,699	+ 8,789	23.85
5	5,257	6,808	+ 1,551	29.50
6	8,111	10,023	+ 1,912	23.58
7	5,682	7,097	+ 1,415	24.93
8	8,630	10,949	+ 2,319	26.40
9	19,825	22,399	+ 2,574	12.96
10	17,036	21,845	+ 4,809	28.22
Total	1,51,105	1,79,884	+28,779	19.04
		Bhagalpur		
1	21,504	23,614	+ 2,110	9.81
2	17,077	22,061	+ 4,984	29.18
3	15,034	15,107	+ 73	0.48
4	7,251	8,446	+ 1,195	16.48
5	17,332	18,309	+ 977	5.63
6	10,977	13,742	+ 2,765	25.18
7	22,014	29,094	+ 7,080	32.16
8	21,012	25,937	+ 4,925	23.43
9	11,649	16,392	+ 4,743	40.80
Total	1,43,850	1,72,202	+28,352	19.70

(*Contd.*)

APPENDIX V (*Contd.*)

1	2	3	4	5
		Biharsharif		
1	4,729	5,700	+ 971	20.50
2	5,015	6,408	+ 1,393	27.77
3	4,848	6,097	+ 1,249	25.75
4	5,555	6,009	+ 454	8.17
5	2,337	3,228	+ 8,091	38.12
6	5,555	7,161	+ 1,606	28.70
7	3,802	5,492	+ 1,690	47.00
8	5,263	6,370	+ 1,107	21.03
9	6,186	7,956	+ 1,770	28.61
10	3,525	6,592	+ 3,067	87.00
11	5,600	6,173	+ 573	10.23
12	5,609	7,725	+ 2,116	37.72
13	3,926	5,751	+ 1,825	46.45
14	6,516	7,336	+ 820	12.57
15	4,971	6,262	+ 1,291	25.70
16	5,144	5,786	+ 642	12 47
Total	78,581	1,00,046	+21,465	27.01

APPENDIX VI

Some Indicators of Intra-Urban Variation of Population

Distance from city centre (in miles)	Y	X_1	X_2	X_3	X_4	X_5
1	2	3	4	5	6	7
			Patna			
0.50	109.55	145.65	46.64	29.45	6.53	61.04
1 00	60.92	110.55	44.90	26.29	5.89	63.70
1.50	41.31	85.60	34.72	23.82	8 37	56.45
2 00	38.39	141.65	23.75	19.80	8.34	55.34
2.50	36.86	65.30	24.62	17.79	8.59	55.40
3.00	35.07	61.80	24.66	17.26	7.89	56.83
3.50	22.75	43.85	20.43	16.69	8.75	54.28
4.00	24.37	84.72	17.99	17.18	9.24	53.93
4.50	40.66	105.55	34.56	17.99	9.29	49.53
5.00	57.97	135.45	39.06	20.60	9.40	47.97
5.50	48.94	103.82	28.29	19.87	12.88	45.18
6.00	30.22	44.44	32.58	17.31	14.48	41.34
6.50	12.40	25.00	31.58	15.45	13.65	35.10
7.00	12.20	12.40	24.91	14.70	13.90	35.13
			Jamshedpur			
0.50	50.22	47.95	55.10	22.89	4.80	63.64
1.00	24.05	37.75	28.46	20.56	9.74	61.54
1.50	26.56	43.45	21.75	22.77	8.70	60.88
2.00	25.50	45.75	14.62	11.24	10.20	61.28
2.50	22.69	34.35	16.99	11.57	9.15	57.81
3.00	20.22	28.40	19.57	9.57	10.30	57.67
3.50	17.62	19.35	18.40	6.71	13.40	55.48
4.00	11.01	17.45	13.68	6.65	15.18	55.77
4.50	5.64	15.50	9.58	5.06	13.45	52.25
5.00	1.26	8.10	10.12	3.75	13.85	50.48
			Ranchi			
0.50	96.24	36.20	50.49	27.48	15.41	62.31
1.00	35.45	21.00	24.43	25.34	17.51	61.35
1.50	21.18	17.40	22.33	23.77	16.31	59.42
2.00	14.38	16.00	16.13	23.33	15.97	60.88
2.50	8.98	10.50	13.52	18.88	18.59	61.35
3.00	6.47	7.75	16.77	16.34	18.00	60.37
3 50	16.00	5.10	23.08	17.79	16.40	61.75
4.00	17.64	3.15	23.45	9.65	16.61	57.66
4.50	9.91	1.70	11.18	5.72	17.40	54.23
5.00	4.63	0.80	6.37	1.60	17 51	51.25

(Contd.)

APPENDIX VI (*Contd.*)

1	2	3	4	5	6	7
			Gaya			
0.50	93.83	33.05	42.25	33.60	9.71	52.08
1.00	34.39	21.05	20.00	22.75	9.98	47.59
1.50	27.60	15.45	12.68	22.50	8.88	45.74
2.00	10.42	10.30	11.29	20.17	11.38	40.73
2.50	5.47	3.40	10.36	19.83	11.37	38.82
3.00	2.68	1.50	9.03	17.57	10.85	37.39
			Bhagalpur			
0.50	65.45	31.20	46.52	32.23	6.14	51.15
1.00	33.72	15.90	21.97	24.22	7.26	47.67
1.50	15.73	12.55	17.69	24.20	7.52	45.71
2.00	15.40	9.30	16.91	17.10	8.08	43.34
2.50	11.60	9.15	13.43	17.44	7.76	45.07
3.00	25.66	11.10	11.24	16.10	7.85	47.05
3.50	20.52	7.25	16.73	11.98	7.72	44.80
			Darbhanga			
0.50	54.81	26.90	42.24	27.48	10.25	40.84
1.00	30.52	14.43	23.47	24.18	12.03	40 29
1.50	24.87	10.75	24.82	23.59	11.51	37.78
2.00	23.94	7.42	24.19	22.83	12.55	41.20
2.50	21.09	6.60	20.37	20.10	10.52	39.25
3.00	17.94	4.35	25.92	12.05	12.24	35.75
3.50	12.50	1.45	14.43	7.55	12.15	34.24
			Muzaffarpur			
0.50	67.07	45.80	52.58	36.22	6.45	56.00
1.00	39.00	15.05	23.77	26.34	7.70	52.58
1.50	18.19	12.35	13.42	21.69	9.20	48.39
2.00	8.53	4.10	14.61	17.81	10.42	46.91
2.50	1.53	1.05	10.09	9.50	10.63	43.35
			Monghyr			
0.50	67.88	31.25	46.42	28.62	6.89	52.85
1.00	35.85	11.45	31.21	17.76	6.90	46.42
1.50	14.60	3.22	30.42	12.96	7.86	32.92
2.00	10.28	0.80	20.72	5.22	7.50	40.54
2.50	9.00	0.30	17.40	5.11	8.15	30.46

(*Contd.*)

APPENDIX VI (*Contd.*)

1	2	3	4	5	6	7
			Biharsharif			
0.50	61.89	31.62	28.51	26.62	6.12	42.40
1.00	25.92	16.20	19.13	21.62	8.43	36.42
1.50	26.81	2.90	18.82	16.77	9.20	34.49
2.00	24.04	2.60	26.12	24.47	10.03	37.20
2.50	18.15	0.90	22.95	19.40	10.53	33.18

Dependent Variable :

Y=Population Density.

Independent Variables :

X_1=Commercial Area (in acres).

X_2=Accessibility (length of road in feet per acre).

X_3=Urban Function (Workers per acre in Trade and Commerce).

X_4=Proportion of Scheduled Caste and Scheduled Tribes (per cent of Total Population).

X_5=Literacy (Per cent of Total Population).

APPENDIX VII

Ward Nos.	Area (in Acres)	Population (1971)	Population Density Persons/ Acre	Density of Workers in Trade & Commerce Persons/ Acre	Literacy (in %)	S. Castes and S. Tribes (in %)
1	2	3	4	5	6	7
			Patna			
1	952.40	15,099	15.02	0.2	59.47	8.70
2	1,343.20	10,766	8.00	0.0	68.53	8.25
3	1,093.60	18,665	7.06	0.6	52.25	11.60
4	761.60	22,599	29.65	1.1	60.69	4.47
5	296.00	8,465	28.60	1.8	55.42	12.27
6	790.80	7,730	9.56	0.4	59.74	11.70
7	83.40	11,691	140.46	9.8	62.04	12.14
8	499.20	16,931	33.85	1.2	60.04	12.53
9	262.40	10,226	39.03	3.1	66.02	11.57
10	317.20	11,840	37.34	4.0	60.76	6.35
11	803.80	17,634	21.43	1.3	59.52	4.83
12	210.60	13,702	64.93	3.6	59.45	9.79
13	124.40	13,510	108.93	10.5	65.47	3.42
14	482.80	23,090	47.80	2.3	57.44	10.66
15	60.80	12,096	201.54	18.8	61.79	1.75
16	92.00	12,457	144.84	10.0	60.15	6.26
17	164.00	16,081	98.05	7.1	59.66	6.38
18	652.20	15,957	24.47	1.6	69.01	4.95
19	102.40	10,550	103.43	6.8	49.73	7.61
20	179.20	10,558	58.82	3.3	59.32	3.82
21	1,209.00	13,693	11.32	0.4	36.82	13.12
22	243.20	10,340	42.55	1.9	46.18	7.38
23	185.60	11,298	60.74	2.2	45.20	3.50
24	1,433.60	12,302	8.57	0.3	40.40	8.19
25	160.00	12,321	77.00	4.4	47.36	7.07
26	1,049.60	13,819	13.16	0.6	41.29	12.07
27	179.20	10,732	59.95	2.0	52.91	7.04
28	211.20	11,840	56.11	2.5	41.08	10.19
29	1,558.80	10,679	6.30	0.1	29.71	11.04
30	83.20	10,274	123.78	12.2	46.71	4.92
31	153.60	12,471	80.98	3.1	45.64	12.22
32	61.20	9,726	159.44	17.7	64.38	1.69
33	345.60	9,096	26.23	3.1	47.76	6.90
34	89.60	10,911	121.23	5.6	44.56	10.26
35	172.80	10,205	58.98	5.2	44.82	15.32
36	366.40	13,701	37.49	1.2	40.02	14.37
37	690.00	9,969	44.45	0.2	32.79	13.76

(Contd.)

APPENDIX VII (*Coutd.*)

1	2	3	4	5	6	7
Patliputra Colony	158.00	2,290	14.42	0.1	53.35	2.04
Phulwari Sharif	1,601.20	15,917	9.94	0.2	61.82	9.61
Total	19,224.20	4,91,217	25.55	1.4	53.27	8.47
			Jamshedpur			
1	259.20	17,255	66.61	1.7	48.78	9.53
2	382.40	2,187	5.72	0.1	53.68	16.14
3	441.20	6,239	14.12	0.2	61.43	4.65
4	963.20	18,001	19.00	0.7	54.83	12.53
5	126.40	5,676	45.05	0.2	78.82	4.05
6	224.00	5,151	23.00	0.3	80.10	1.65
7	121.60	8,810	72.21	0.6	62.49	3.70
8	152.80	9,593	62.70	0.5	65.88	5.56
9	180.80	11,681	64.53	2.91	45.79	23 48
10	184.00	923	5.01	0.0	78.65	—
11	911.20	4,653	5.11	0.1	66.66	6.96
12	40.00	1,342	33.55	3.5	62.96	4.24
13	57.60	2,235	38.52	2.2	84.31	0.53
14	144.00	6,761	46.80	2.8	69.69	1.33
15	224.00	324	1.45	0.2	25.00	8.33
16	—	—	—	—	—	—
17	64.00	5,692	88.93	1.3	66.35	3.58
18	212.80	2,893	13.57	2.0	74.31	1.03
19	92.80	7,559	81.11	2.2	79.09	5.68
20	262.40	13,366	51.01	0.8	54.04	3.04
21	41.60	4,038	96.14	4.4	65.57	2.03
22	78.40	4,691	7.14	6.5	70.11	1.57
23	314.20	10,584	33.35	0.7	47.49	24.58
24	264.00	12,018	45.52	1.8	76.99	4.86
25	284.80	20,927	73.06	0.3	56.51	17.17
26	190.40	12,964	67.50	3.6	52.70	9.76
27	—	—	—	—	—	—
28	28.80	2,674	68.22	3.2	59.91	1.90
29	179.20	7,045	39.30	0.6	64.82	9.73
30	102.40	1,162	11.38	0.1	76.93	1.03
31	80.00	1,692	21.14	0.5	33.03	48.40
32	427.20	8,860	20.40	0.5	63.09	9.76
33	904.00	4,282	4.73	0.1	57.56	11.84
34	980.20	2,254	2.27	0.0	67.56	11.31
35	1,432.40	19,963	13.92	0.0	76.01	2.43
36	416.00	3,187	7.63	0.2	51.00	3.45
37	462.60	22,262	48.19	0.7	57.26	9.16
38	1,545.80	15,652	10.12	0.1	63.39	12.05
39	637.80	11,707	18.33	0.1	70.52	2.59
40	136.00	4,643	34.06	0.2	74.49	7.12

(*Contd.*)

APPENDIX VII (*Contd.*)

1	2	3	4	5	6	7
41	2,228.80	39,434	17.69	0.8	41.83	18.95
42	1,301.80	1,139	0.87	0.0	59.17	2.72
Jugsalai	910.70	27,364	30.00	2.8	60.02	4.82
Bagbera	2,270.25	28,053	11.37	0.0	34.09	32.76
Kalimati	3,555.75	15,207	4.44	0.1	40.45	41.97
Adityapur	4,693.00	28,226	6.44	0.0	37.03	10.35
Total	28,753.70	4,56,145	15.87	1.0	56.60	12.85
			Ranchi			
1	1,717.20	21,460	12.49	0.9	67.80	9.13
2	763.60	26,082	34.13	3.8	59.02	5.72
3	835.60	31,079	37.17	2.3	52.08	12.03
4	329.60	21,201	64.24	4.2	62.74	26.35
5	281.60	11,791	41.80	2.2	71.30	29.74
6	2,126.20	26,413	12.42	0.4	54.10	32.16
7	3,433.40	37,908	11.04	0.4	61.04	21.48
Doranda	1,080.40	23,954	22.17	0.8	62.49	11.36
Jaganath-nagar	7,615.90	55,663	7.30	0.1	56.43	15.61
Total	18,183.50	2,55,551	14.04	0.6	59.30	17.33
			Gaya			
1	692	30,408	43.94	2.2	48.38	12.85
2	74	9,497	126.17	14.0	57.31	4.35
3	75	15,159	202.12	24.2	51.75	13.85
4	1,272	45,699	36.48	2.3	49.11	8.74
5	172	6,808	38.40	3.1	53.61	8.76
6	68	10,023	162.10	9.0	51.22	3.61
7	76	7,097	93.38	5.5	62.98	1.91
8	1,124	16,947	15.07	0.4	22.93	17.33
9	1,332	22,399	16.81	0.6	52.02	9.29
10	1,950	21,845	11.20	0.4	31.23	8.42
Total	6,835	1,79,884	26.31	1.6	47.84	8.58
Excluding the area of Phalgu river						
			Bhagalpur			
1	1,817.6	23,614	12.98	0.2	43.81	8.79
2	2,288.4	22,061	17.91	0.8	60.73	5.90
3	322.4	15,107	46.91	4.1	60.61	6.16
4	137.2	8,446	61.65	8.2	63.88	2.04
5	521.2	18,309	35.13	2.1	49.77	4.80
6	1,139.2	13,742	12.06	0.5	35.16	8.09

(*Contd.*)

APPENDIX VII (*Contd.*)

1	2	3	4	5	6	7
7	630 0	29,094	46.17	1.3	45.23	4.25
8	854.0	25,437	29.78	1.8	36.81	8.26
9	752.0	16,392	21.81	0.1	40.60	9.67
Total	7,462.40	1,72,202	23.07	2.1	47.29	6.60
			Darbhanga			
1	260.62	2,595	9.94	0.4	20.53	9.94
2	230.68	3,652	15.76	0.6	35.29	17.16
3	250.25	3,288	13.19	0.4	27.83	26.22
4	102.50	3,310	32.45	2.1	40.33	14.89
5	72.81	3,186	43.64	3.6	31.76	3.95
6	492.42	2,605	5.18	0.4	64.91	2.26
7	230.90	3,676	15.90	0.5	24.94	41.13
8	47.00	4,030	85.90	4.4	50.66	10.44
9	284.53	4,566	16.02	0.4	49.51	15.98
10	159.83	3,038	18.98	1.5	47.00	4.97
11	125.48	3,578	28.62	2.1	46.11	5.86
12	120.57	4,056	33.52	1.3	26.25	18.19
13	71.51	2,350	32.76	3.2	25.84	15.72
14	54.08	4,326	80.00	5.2	59.47	1.60
15	76.51	4,067	52.81	3.9	42.56	9.73
16	190.51	3,806	20.00	0.8	45.37	6.09
17	80.47	4,061	50.76	2.8	39.25	9.06
18	42.73	4,717	109.69	5.3	41.21	21.72
19	65.30	4,141	63.70	6.9	39.53	2.87
20	124.91	2,426	19.40	0.5	30.58	23.00
21	186.41	5,695	30.61	2.5	34.41	4.93
22	91.79	4,875	52.96	3.0	48.09	3.87
23	165.13	3,322	20.14	1.3	32.14	7.04
24	203.62	4,170	20.38	0.7	44.24	14.34
25	77.63	4,545	58.27	2.7	49.37	9.10
26	80.54	4,255	52.53	2.7	50.22	2.35
27	102.00	4,181	40.99	2.6	54.31	4.87
28	207.83	5,315	25.55	0.9	51.40	14.16
29	170.33	5,177	31.04	2.4	66.71	3.38
30	85.94	4,735	53.79	4.1	34.17	5.25
31	82.51	4,875	58.73	6.3	52.82	6.09
32	359.90	9,421	26.17	1.1	48.63	12.24
Total	4,907.24	1,32,059	27.11	2.3	43.53	10.15
			Muzaffarpur			
1	315.20	4,077	12.94	0.6	38.92	9.80
2	624.60	4,907	7.85	0.6	42.71	9.59
3	65.80	4,650	70.45	3.3	47.84	4.79
4	166.04	3,733	22.48	1.3	51.37	9.37

(*Contd.*)

APPENDIX VII (*Contd.*)

1	2	3	4	5	6	7
5	148.80	4,438	29.78	1.7	44.14	8.78
6	279.60	5,153	17.73	1 8	57.34	7 35
7	110.60	3,952	35.63	2.3	66.11	2.55
8	156.60	3,628	23.10	2.3	55.84	6.44
9	24.40	3,592	149.66	25.8	60.13	2.25
10	209.60	5,322	25.34	2.6	40.62	4.22
11	62.40	4,449	71.75	3.1	38 23	14.45
12	169.80	4,184	24.61	1.1	43.49	10.03
13	214.40	4,195	19.60	1.8	33.80	17.92
14	25.00	2,291	91.64	6.3	49.84	0.96
15	67.20	4,495	67.04	4.7	44.11	6.62
16	35.60	3,623	100.63	8.2	64.44	1.79
17	42.00	4,094	97.50	12.0	56.42	1.66
18	24.40	3,309	137.87	20.3	63.64	4.35
19	49.60	3,719	74.38	9.2	63.69	6.93
20	21.20	2,248	107.04	12.7	60.54	0.31
21	22.80	2,847	123.77	10.4	52.86	3.96
22	96.80	5,176	53.35	3.7	39.25	8.11
23	34.00	3,386	99.58	10.7	51.21	5.05
24	92.80	2,809	23.20	2.7	61.51	1.56
25	44.40	3,148	71.54	5.5	56.03	9.68
26	57.60	3,256	56.13	4.0	68.94	11.14
27	225.60	3,969	17.56	0.5	57.92	11.43
28	262.83	4,583	17.42	0.6	70.17	3.73
29	118.60	4,515	37.94	2.6	48.15	6.84
30	107.20	4,366	40.80	2.5	54.30	6.82
31	196.80	4,869	24.71	1.8	32.86	13.73
32	235.60	3,396	14.39	0.5	43.49	17.13
Total	4,318.20	1,26,379	29.27	2.2	50 48	7.55
			Monghyr			
1	340.00	5,389	15.85	0.4	62.33	7.97
2	92.20	3,246	35.28	1.6	54.86	15.31
3	82.00	3,927	45.89	2.2	41.76	11.79
4	93.00	4,838	51.46	1.6	48.55	10.45
5	190.00	2,360	15.08	0.2	31.56	1.44
6	208.50	3,375	16.14	0.3	35.79	7.82
7	127.30	4,592	36.15	1.0	52.48	3.70
8	29.60	1,503	50.10	3.6	49.96	4.72
9	10.00	3,391	340.00	10.7	46.03	9.37
10	28.00	3,113	111.17	4.3	52.16	4.11
11	50.00	3,233	64.66	1.7	41.23	5.69
12	77.10	3,822	49.65	0.4	61.17	2.32
13	176.90	3,434	19.40	0.1	41.08	9.26
14	177.50	1,676	9.40	0.5	38.12	2.26
15	161.00	2,910	18.08	3.2	41.06	7.42
16	39.70	3,691	92.27	16.5	44.81	4.87

(*Contd.*)

APPENDIX VII (*Contd.*)

1	2	3	4	5	6	7
17	22.30	2,073	94.22	7.7	71.68	0.00
18	27.70	2,593	92.60	6.8	55.64	0.42
19	30.80	3,080	90.58	4.0	59.12	0 00
20	45.95	4,381	95.23	4.1	51.06	8.85
21	81.10	5,249	64.80	1.2	45.09	0.80
22	45.70	1,911	41.54	0.0	44.21	4.55
23	174.90	2,050	11.77	0.6	16.04	14.48
24	71.10	1,604	22.59	0.8	45.38	12.65
25	85.80	2,599	30.22	4.5	43.32	5 65
26	48.20	3,193	66.52	0.3	52.38	5.82
27	292.60	3,579	12.21	0.1	47.72	9.33
28	333.80	3,373	10.09	0.2	38.54	9.75
29	170.50	1,975	11.55	1.5	40.25	14.68
30	85.50	2,997	34.85	0.2	31.49	7.94
31	92.60	873	9.38	1.5	49.02	9.62
32	313.90	3,306	10.52	0.2	37.59	1.81
33	166.40	3,178	18.90	0.1	36.71	3.60
Total	4,318.20	1,02,475	23.73	1.0	46.48	6.48
			Biharsharif			
1	546.00	5,700	10.43	0.6	32.56	12.42
2	310.20	6,408	20.60	0.1	37.73	7.10
3	170.30	6,097	35.65	2.3	37.29	5.74
4	108.00	6,009	46.94	6.0	45.81	5.69
5	54.20	3,228	59.77	5.6	48.42	3.25
6	375.40	7,161	19.09	0.8	36.37	12.66
7	155.00	5,492	35.43	1.6	42.62	4.57
8	202.50	6,370	31.43	1.5	51.82	5.55
9	384.20	7,956	20.72	1.2	33.14	10.97
10	201.00	6,592	31.09	1.2	39.86	11.99
11	295.40	6,173	20.82	0.6	26.64	12.55
12	403.00	7,725	19.12	0.7	48.14	3.48
13	275.30	5,751	20.90	0.7	30.08	10.97
14	251.00	7,336	29.11	0.6	31.05	2.00
15	198.20	6,262	31.62	3.0	44.71	4.64
16	201.30	5,786	28.73	0.4	37.34	13.03
Total	4,131.00	1,00,046	24.21	1.3	39.01	9.31

Source : District Census Handbooks, 1971, Patna, Singhbhum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr.

BIBLIOGRAPHY

Ahmad, E., Distribution of Cities in India and Pakistan, Geographical Outlook, Vol. 1, 1956.

Ahmad, E., Origin and Evolution of Towns in Uttar Pradesh, *Geographical Outlook*, Vol. 1, 1956.

Ahmad, Kazi, Indian Cities: Characteristics and Correlation, University of Sind, Hyderabad, West Pakistan, 1965.

Alam, S.M., Hyderabad-Secunderabad: Study in Urban Geography, Allied Pub., Bombay, 1965.

Alam, S.M. and Pokshishevsky, V.V. (Ed.), Urbanisation in Developing Countries, Osmania University, Hyderabad, 1976.

Alexandersson, G., The Industrial Structure of American Cities, Lincoln, University of Nebraska Press, 1956.

Alonso, W., Location and Landuse: Towards a General Theory of Land Rent, Cambridge Mass, Harward Univ. Press, 1964.

Anderson, N., The Urban Community: A World Perspective; Holt, Rinehart and Winston, New York, 1959.

Bagchi, K., The Howrah Conurbation: A City in Urban Sprawl; *Geographical Review of India*, Vol. 28, 1966.

Beaujeu, J.B. and Garnier, G.C., Urban Geography, Longman, London, 1967.

Berry, Brian J.L., Geography of Market Centres and Retail Distribution, Englewood Cliffs, Prentice-Hall, New Jersey, 1967.

Berry, Brian and Garrison, W.L., Annals of the Association of American Geographers, Vol. 48, 1958.

Berry, Brian J.L. and Horton, E.F., Geographic Perspective on Urban System: With Integrated Readings, Prentice-Hall, Inc., Englewood Cliffs, New York, 1970.

Berry, Brian J.L. and Marble, D.F. (Ed.), Spatial Analysis: A Reader ir Statistical Geography, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

Berry, Brian J.L. and Rees, R.H., The Factorial Ecology of Calcutta *American Journal of Sociology*, 1969.

Berry, Brian J.L. and Tennant, R.J. and Simmon, Urban Population Densities: Structure and Change, *Geog. Rev.*, Vol. LIII, 1963.

Bhatacharya, N.D , Murshidabad: A Study in Urban Geography, *Journal of India*, Vol. 5, 1959.

Bogues, Donald and Zacharia, K.C., Urbanisation and Migration in India, India's Urban Future (Ed. Roy and Turner), University of California Press, Berkeley, 1962.

Borchert, R.J., The Twin Cities Urbanised Area: Past, Present and Future, *Geographical Review*, Vol. 5, 1961.

Bose, Ashis, Urbanisation in India, Academic Books Ltd., Bombay, 1970.

Bourne, L.S., Internal Structure of the City, Oxford University Press, Toronto, 1971.

Breese, G., Urbanisation in Newly Developing Countries, Prentice-Hall, Englewood Cliffs, 1966.

Breese, G., Urban Development Problems in India, *Annals of the Association of American Geographers*, Vol. 53, 1963.

Browing, H.L., Selectivity of Migrants to a Metropolis in a Developing Country (A Mexican Case Study), *Demography*, Vol. 6, 1969.

Brush, John E., Spatial Patterns of Population in Indian Cities, *Geographical Review*, Vol. 58, 1968.

Brush, John E., Morphology of Indian Cities, India's Urban Future (Ed. Roy and Turner), California University Press, Berkeley, 1962.

Brush, John E., Application of a Model to the Analysis of Population Distribution in Indian Cities in Urban Geography in Developing Countries (Ed. Singh, R.L.), *The National Geog. Society of India*, Varanasi, 1973.

Brush, John E., The Hierarchy of Central Places to the Western Wisconsin, *Geographical Review*, Vol. 43, 1953.

Brush, John E., Growth and Spatial Structure of Indian Cities in 'Indian Urbanisation and Planning, (Ed. Noble, A.G. and Dutt, A.K.), Tata McGraw Hill Publishing Co., New Delhi, 1977.

Carry, W.G., The Regional Interpretation of Manhattan Population and Housing Patterns Through Factor Analysis, *Geographical Review*, 1968.

Carter, H., The Study of Urban Geography, Edward Arnold, London, 1975.

Casparis, J., Shopping Centre Location and Retail Store in a Metropolitan Area, *Demography*, Vol. 10, 1969.

Chandrashekhar, S., Growth of Population in Madras City, Population Review, *Indian Institute for Population Studies*, Madras, 1964.

Chatterjee, A.B., Demographic Features of Howrah City, *Geog. Rev. of India*, Vol. 20, 1958.

Chorley, J.R. and Hagget, P. (Ed.), Socio-Economic Models in Geography, Methuen, London, 1967.

Clark, C., Population Growth and Land Use, Macmillan, London, 1967.

Colby, C.C., Centrifugal and Centripetal Forces in Urban Geography, *Annals of the Association of American Geographers*, Vol. 23, 1933.

Cole, J.P. and King, C.A.M., Quantitative Geography, Willey, London, 1968.

David, W., The Pre-Urban Cadaster and the Urban Patterns, *Annals of the Association of American Geographers*, Vol. LII, 1962.

Davis, K., Population of India and Pakistan, Princeton Univ. Press, New Jersey, 1951.

Dayal, P., Population Growth and Rural-Urban Migration in India, *National Geographical Journal of India*, Vol. V, 1959.

Dayal, P. and Thakur, B., Commercial Ribbons of Patna, *National Geographical Journal of India*, Vol. XXII, 1976.

Desai, P.B., Size and Composition of Population in India (1901-61), Asia Publishing House, Bombay, 1969.

Despandey, C.D., Cities and Towns of Bombay Province, *Indian Geog. Journal*, Vol. 16, 1941.

Dewar, D., Nearest Neighbour Analysis as a Measurement of Structural Variation within Shopping Centres, *South African Geographer*, Vol. III, 1971.

Diwakar, R.R. (Ed.), Bihar Through the Ages, Orient Longmans, London, 1958.

Dubey, K.K., Use and Misuse of Land in Kewal Towns, Ph.D. thesis (Unpub), Varanasi, 1966.

Duncan, O.D., The Measurement of Population Distribution, *Population Studies*, Vol. 15, 1957.

Duncan, O.D. and Reiss, A.J., Social Characteristics of Urban and Rural Communities, John Willey & Sons, New York, 1950.

Dutt, A.K., Jamshedpur and its Umland: A Study in Urban Geography, Ph.D. thesis (Unpub.), Patna Univ., 1959.

Dutt, A.K., Intra-City Hierarchy of Central Places, Calcutta, Professional Geographer, Vol. 21, 1969.

Dutt, A.K. (Ed.), India: Resources, Potentialities and Planning, Dubuque, Iowa, Kendall-Hunt Publishing Co., 1973.

Dutt, A.K. and Noble, A.G., Indian Urbanisation and Planning, McGraw Hill Publishing Co., New Delhi, 1977.

Dwivedi, G., Origin and Growth of Allahabad, *Indian Geographical Journal of India*, Vol. 38, 1963.

Dwyer, D.J., The City in Developing World and the Example of South East, *Geography*, Vol. 53, 1968.

Fine, Glenn and Others, The Residential Segregation of Occupational Groups in Central Cities and Suburb, *Demography*, Vol. 8, 1971.

Fry, Maxwel and Drew, J.B., Chandigarh and Urban Review, Vol. LI, 1955.

Fryer, D.W., The Million City in S.E. Asia, *Geographical Review*, Vol. 43, 1953.

Fuguit, G.V. and Field, D.R., Some Population Characteristics of Villages Differentiated by Size, Location and Growth, *Demography*, Vol. 9, 1972.

Funch, R.J., "Intra-Urban Variation of Residential Quality, *Eco. Geog.*, Vol. XXXVI, 1960.

Garrison, W.L., Spatial Structure of the Economy, *Annals of the Association of American Geographers*, Vol. 49, 1959-60.

Ghos, S., The Urban Patterns of Calcutta, *Ecology*, Vol. XXVI, 1950.

Ghurye, G.S., Cities in India, *Sociological Bulletin-II*, 1953.

Ghurye, G.S., Cities and Civilisation, Popular Prakashan, Bombay, 1967.

Gibbs, J.P. (Ed.), Urban Research Methods, Nostrand Co., New York, 1961.

Gist, N.P. and Halbert. L.A., Urban Society, Thomas Cornwell Comp., New York, 1954.

Gold Stain, Urbanisation in Thailand, *Demography*, Vol. 8, 1971.

Gopal, Krishnan, Spatial Analysis of Vegetable Supply of a Planned City, Chandigarh, *Indian Geog. Journal*, Vol. 38, 1963.

Gregory, S., Statistical Methods and the Geographers, Longmans, 1963.

Gross, Edward, The Role of Density as a Factor in Metropolitan Growth in the U.S.A., *Population Studies*, Vol. 8, 1954.

Guest, A.M., The Applicability of the Burgess Zonal Hypotheses of Urban Canada, *Demography*, Vol. 6, 1969.

Guest, A.M., Urban History, Population Densities and Higher Status Residential Location, *Eco. Geog.*, Vol. 48, 1972.

Guest, A.M., Urban Growth and Population Densities, *Demography*, Vol. 10, 1973.

Guha, M. and Chatterjee, A.B., Serampore: A Study in Urban Geography, *Geographical Review of India*, Vol. 16, 1954.

Gurevich, B.L., The Density of Population of a City and the Density of Probability of Random Magnitude, *Soviet Geography, Review and Translation*, Vol. 8, 1967.

Haff, P. and Reiss, K. (Ed.), Cities and Society, Free Press, Glencoe, Illinois, 1957.

Hagget, P., Locational Analysis in Human Geography, Edward Arnold, London, 1965.

Hagget, P. and Chorley, R.J., Network Analysis in Geography, Edward Arnold, London, 1969.

Hall, A.D., The World Cities, Weidenfeld and Nicholson, London, 1966.

Harris, Chauncy, D. and Ullman, E.I., The Nature of Cities Readings in Urban Geography (Ed. Mayer and Khane), Chicago, 1959.

Hart, J.F., Central Tendency in Geographical Distribution, *Eco. Geog.*, Vol. 30, 1954.

Hawley, A.H., Human Ecology: A Theory of Community Structure, Ronald Press, New York, 1950.

Hawley, A.H., Population Density and the City, *Demography*, Vol. 9. 1972.

Haynes, E.K. and Rub, I.M., Directional Bias in Urban Population Density, *Annals of the Association of American Geographers*, Vol. 63, 1973.

Hoover, E.M., Location Theory, Harward University Press, Cambridge, 1937.

Hoover, E.M., The Location of Economic Activity, McGraw Hill, New York, 1948.

Hoover, E.M. and Ramond, V., Anatomy of a Metropolis: The Changing Distribution of People and Jobs within the New York Metropolitan Region, Doubleday & Co., Garden City, 1962.

Hoslitz, B.F., The Cities of India and Their Problems: A Review Article, *Annals of the Association of American Geographers*, 1959.

Hoslitz, B.F., Indian Cities: The Survey of Calcutta, Kanpur and Jamshedpur, *Economic Weekly*, 1961.

Houser, Phillip, M., Urbanisation in Asia and Far East, NESCO, Calcutta, 1957.

Hoyt, H., The Pattern of Movement of Residential Rental Neighbourhoods; Readings in Urban Geography (Ed. Mayer and Khane), Chicago, 1959.

Hunt, A.J. and Moisley, H.A., Population Mapping in Urban Areas, *Geography*, Vol. 45, 1960.

Isard, W., Location and Space Economy, M.I.J. Press, Cambridge, 1956.

Jefferson, M., The Law of the Primate City, *Geog. Rev.*, Vol. 29, 1939.

Johnson, J.L., Centrality Within a Metropolis, *Eco. Geog.*, Vol. XIV, 1970.

Johnson, R.J., Spatial Patterns in the Residential Structure of Cities, *The Canadian Geographer*, Vol. XIV, 1970.

Johnston, R.T., Spatial Structure, Methuen & Company, London, 1973.

Joshi, R.V., Urban Structure in Western India (Poona Sample Study), *Geographical Review of India*, Vols. 13-14, 1952.

Kar, N.R., Demographic; Economic, Social Correlates and Typology of

Indian Cities, Approach to Urban Studies in India, Census of India, Pub., 1961.

Karan, P.P., Patna and Jamshedpur, *Geographical Review of India*, Vol. XIV, 1952.

Kariel, H.G., Selected Factors Areally Associated with Population Growth Due to Net Migration, *Annals of the Association of American Geographers*, Vol. 53, 1963.

Kenneth, L., Duration of Residence and Prospective Migration (Further Evidence), *Demography*, Vol. 6, 1969.

King, L.J., A Multivariate Analysis of the Spacing of Urban Settlements, in the USA, *Annals of the Asso. of American Geographers*, Vol. 51, 1961.

King, L.J., Statistical Analysis in Geography, Englewood Cliffs, Prentice-Hall, 1969.

Krischenbaunu, A., City Suburban Destination Choices Among Migrants to Metropolitan Area, *Demography*, Vol. 9, 1972.

Kuppaswami, B., Social Change in India, International Book Ltd., England, 1972.

Kurian, G., Distribution of Population in the City of Madras, *Indian Geog. Journal*, Vol. 16, 1941.

Lal, Amrit, Patterns of Immigration in Indian Cities, *Geographical Review of India*, Vol. 23, 1961.

Lal, Amrit, Age and Sex Structure of Cities of India, *Geographical Review of India*, Vol. 24, 1962.

Lakshman, T.R., An Approach to the Analysis of Intra-Urban Location Applied to Baltimore Region, *Eco. Geog.*, Vol. 34, 1964.

Lea, R.H., The City Urbanism and Urbanisation in Major World's Region, Chicago, 1955.

Losch, A., The Economic of Location, Yale Univ. Press, New Haven, Conn., 1954.

Margaret, R., Town Planning Techniques, Hutchinson & Co. Ltd., London, 1974.

Marsden, B.S., Temporal Aspects of Urban Population Densities, Brisbane (1861-1966), *Aust. Geog. Studies*, Vol. VIII, 1970.

Mayer, H.M. and Kohne, C.F. (Ed.), Readings in Urban Geography, Central Book Depot, Allahabad, 1967.

McKenzie, R.D., Metropolitan Community, McGraw Hill, New York, 1933.

Mehta, S.K., Patterns of Residence in Poona (India), By Caste, *Demography*, 1969.

Mishra, B.R., Report on Socio-Economic Survey of Jamshedpur City, Patna University, Patna, 1959.

Mishra, R.P., Regional Planning Concepts, Techniques, Policies and Case Studies, Prasaranga, The University of Mysore, 1969.

Mookerjee, D., The Urban Patterns of Siliguri, *Geog. Rev. of India*, Vol. 19, 1957.

Mukherjee, A.B., Modinagar: A Study in Urban Geography, *Geog. Rev. of India*, Vol. 15, 1953.

Mukherjee, S., The Growth of Nagpur City, *Geographical Outlook*, Vol. 2, 1958.

Murdie, R.A., A Reply "On Spatial Patterns in the Residential Structure of Cities", *The Canadian Geographers*, Vol. XIV, 1970.

Murphy, R.E., The American City: An Urban Geography, McGraw Hill Book Co., New York, 1966.

Muth Richard, F., Cities and Housing: The Spatial Pattern of Urban Residential Landuse, Chicago Univ. Press, Chicago, 1968.

Nath, V., Urbanisation in India with Spatial Reference to the Growth of Cities, United Nations Proceedings of the World Population Conference (1954), New York, 1955.

Nelson, H.J., Some Characteristics of the Population of Cities in Similar Service Classification, *Eco. Geog.*, Vol. XXXIII, 1962.

Newling, B.E., The Spatial Variation of Urban Population Densities, *Geog. Rev.*, Vol. 59, 1969.

Newling, B.E., Urban Growth and Spatial Structure: Mathematical Models and Empirical Evidence, *Geog. Review*, Vol. 56, 1966.

Noel, P.G., The Ecology of Bangalore, India: An East-West Comparison, *Social Forces*, Vol. 3, 1957.

Northam, R.M., Urban Geography, John Willey & Sons, Inc., New York, 1975.

Papageorgion, G.J., The Impact of the Environment Upon the Spatial Distribution of Population and Land Values, *Eco. Geog.*, Vol. 49, 1973.

Papageorgion, G.J., The Impact of the Environment Upon the Spatial Distribution of Population and Landuse, *Eco. Geog.*, Vol. 49, 1973.

Papageorgion, G.J. and Casette, E., A Spatial Equilibrium Model of Urban Structure, *Canadian Geographer*, Vol. XV, 1971.

Parr, B.J., City Hierarchy and the Distribution of City Size, *Journal of Regional Science*, Vol. 9, 1969.

Parr, B.J., Theoretical Problem in Central Place Analysis, *Eco. Geog.*, Vol. 46, 1970.

Parson, T., The Social System, Free Press, New York, 1964.

Peach, C., Urban Social Segregation, Longman, London, 1975.

Peter, E., Lloyd and Peter Dicken, Location in Space: Theoretical Approach to Economic Geography, Harper and Row, New York, 1972.

Peter, T. and Peter, T.N., Techniques in Human Geography, McMillan Education Ltd., London, 1971.

Preston, S.H., Empirical Analysis of the Contribution of Age Composition to Population Growth, *Demography*, Vol. 7, 1970.

Queen, S.A. and Carpenter, D.B., The American City, McGraw Hill Book Co., New York, 1953.

Quinn, J.A., Urban Sociology, Eurasia Pub. House Ltd., New Delhi, 1967.

Ranganathan, H.N., Recent Trend in Birth Order Statistics in Poona, *Population Review*, Vol. 9, 1965.

Rannels, J., The Core of the City, Columbia Univ. Press, New York, 1956.

Rao, V.K.R.V. and Desai, P.B., Greater Delhi: A Study in Urbanisation (1940-1957), Asia Pub. House, New Delhi, 1964.

Raynold, R.B., Statistical Method in Geographical Research, *Geog. Rev.*, Vol. 46, 1956.

Raza, Moonis, Urbanisation in Pre-Historic India, *Geographer*, Vol. 4, 1951.

Richard, W.R., Demographic and Ecological Study of Rangoon, Burma, Contribution to Urban Sociology (Ed. Burgess *et al.*), Chicago, 1953.

Rizvi, S.Q.A., Role of Rivers in the Evolution of Urban Centres, *Geographer*, Vol. VIII, 1956.

Robinson, A.H., A Method for Describing Quantitatively the Correspondence of Geographical Distribution, *Annals of the Association of American Geographers*, Vol. 47, 1957.

Sah, J.B. and Others, Landuse Patterns of India's Cities and Towns, Town and Country Planning Organisation, Housing and Urban Development, Govt. of India, 1966.

Scott, P., The Population Structure of Australian Cities, Australian Geographical Journal, 1965.

Scott, P., Australian C.B.D., *Economic Geography*, Vol. 35, 1959.

Sen, J.C., The Sex Composition of India's Towns with 20,000-50,000 Inhabitants, *Indian Geog. Journal*, Vols. 38-39, 1963.

Simmons, J.W., Changing Residence in the City (A Review of Intra-Urban Mobility), *Geographical Review*, Vol. 58, 1968.

Singh, R.L., Banaras: A Study in Urban Geography, Nand Kishore & Sons, Varanasi, 1955.

Singh, R.L. and Singh, K.N. (Ed.), Urbanisation in Developing Countries, *Geog. Soc. of India*, B.H.U., Varanasi, 1973.

Singh, U., Demographic Structure of Allahabad, *National Geographical Journal of India*, Vol. IV, 1958.

Singh, U., Origin and Growth of Kanpur, *National Geographical Journal of India*, Vol. 5, 1959.

Singh, U., Changes in the Built-up Areas of Kawal Towns in the Ganga Plain, *National Geographical Journal of India*, Vol. XII, 1966.

Singh, R.D., The Rule of Some Areally Associated Factors in Intra-Urban Variations of Population in the Cities of Bihar, *Malaysian Journal of Tropical Geography*, Kuala Lumpur, Malaya, V. III, 1981.

Sinha, R.P., Dhanbad: A Study in Urban Geography, *National Ceographical Journal of India*, Vol. VIII, 1962.

Sjoberg, G., The Pre-Industrial City, Past, Present, Illinois, 1960.

Smailes, A.E., The Geography of Towns, Hutchinson, London, 1953.

Smith, D.M., Patterns in Human Geography, Penguin Books, Ltd., New York, 1975.

Spate, O.H.K. & Ahmad, E., Five Cities of the Gangetic Plain, *Geog. Rev. of India*, Vol. 40, 1950.

Spate, O.H.K. & Ahmad, E., Factors in the Development of Capital Cities, *Geog. Rev. of India*, Vol. 32, 1942.

Spengler, J. and Duncan, O.D., Demographic Analysis, Selected Readings, The Free Press, Glencoe, 1956.

Stewart, J.Q., Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population, *Geog. Rev.*, Vol. XXXVII, 1947.

Stewart, J.Q. & Warntz, W., Some Parameters of the Geographical Distribution of Population, *Geog. Rev.*, Vol. 49, 1959.

Suri, K.B., Towns, Size, Economic Structure and Growth, *Economic Weekly*, Vol. 3, 1968.

Sviatovsky, E.E. & Walter, C.E., The Centrographic Method and Regional Analysis, *Geog. Rev* , Vol. XXVII, 1937.

Thakur, H.N. and Krotkri, K.J., Estimates of Population Size and Growth from the 1952-54 and 1961 Censuses of the Kingdom of Nepal Population Studies, *A Journal of Demography*, Vol. 25, 1971.

Toynbee, A., Cities on the Move, Oxford University Press, New York, 1970.

Treadway, R., Social Components of Metropolitan Population Densities, *Demography*, Vol. 6, 1969.

Turner, Roy (Ed.), India's Urban Future, Oxford Univ. Press, Bombay, 1962.

Weber, A.F., Growth of Cities in the 19th Century, New York, 1899.

Weber, M., The City, Heinemann, London, 1960.

Weber, M.J. & Daly, M.J., Spatial and Temporal Variations in Short Term, Industrial Change Within Cities, *Australian Geographical Studies*, Vol. IX, 1971.

Weller, M. and Maritine, Relative Importance of the Components of Urban Growth in Latin America, *Demography*, Vol. 8, 1971.

Whitelow, J.S., Migration Patterns and Residential Selection in Auckland, Newzealand, *Australian Geographical Journal*, Vol. IX, 1971.

William, A., A Technique for Constructing a Population and Urban Land-use Map, *Eco. Geog.*, Vol. 28, 1952.

Wilson, A.G., Urban and Regional Models in Geography and Planning, John Willey & Sons, London, 1974.

Yeats, H.M., An Introduction to Quantitative Analysis in Economic Geography, McGraw Hill, New York, 1968.

Yeats, H.M. & Garnner, J.B., The North American City, Harper and Row, New York, 1971.

Yeats, M., An Introduction to Quantitative Analysis in Human Geography, McGraw Hill, New York, 1974.

Zachariah, K.C. and Mitra, A., Internal Migration in India, Rural-Urban Differences in S.E. Asia, UNESCO Research Centre on Social Economic Development in S.E. Asia, Enclave, Delhi, 1962.

Zelinsky, W., A Prologue to Population Geography, Prentice Hall, Englewood Cliffs, New Jersey, 1966.

RECORDS AND REPORTS

1. Bihar District Gazetteers—Patna, Singhbhum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr.
2. Buchanan, F., Patna-Gaya Report (1811-12), The Bihar and Orissa Research Society, Patna, 1925.
3. Census of India, 1961, 1971, District Census Handbooks—Patna, Singhbum, Ranchi, Gaya, Bhagalpur, Darbhanga, Muzaffarpur and Monghyr.
4. Census of India (Reports), 1911, 1921, 1931 and 1961.
5. Census of India (Bihar), General Population Table, 1961 & 1971.
6. Census of India, Vol. 1, Part II-A, 1951, Demographic Tables.
7. Census of India, 1961, An Appraisal to Urban Studies in India, Census of India, 1961.
8. Census of India, 1961: Demography of Indian Cities.
9. Draft Master Plans (Town Planning Department, Government of Bihar—Patna, Jamshedpur, Ranchi, Gaya, Bhagalpur, Darbhanga and Muzaffarpur).
10. Imperial Gazetteer of India, Vols. I & II, Oxford University Press, London, 1909.
11. India: A Reference Annual, Ministry of Information and Broadcasting, Government of India, 1975.
12. Techno-Economic Survey of Bihar, Vol. I, Asia Publishing House, New Delhi, 1959.

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